COSPAS-SARSAT BEACON TESTER

BT-611M

User Manual

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Sevastopol 2011

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Safety Notices

The Beacon tester should be serviced by qualified personnel only.

To avoid potential hazards use the beacon tester as specified by this user manual only.

To Avoid Fire or Personal Injury

Use Proper Power Cord. Use the power cord designed for the instrument and authorized in your country only.

Ground The Beacon Tester. The tester is grounded through the grounding conductor of the power cord. To avoid electric shock the tester grounding conductor must be grounded properly, Before making connections to the input or output terminals of the tester.

Do Not Operate Without Covers. Do not operate the tester with covers or panels removed.

Use Proper Fuse. Use the fuse of the type, voltage and current ratings as specified for the tester.

Do not operate in Wet/ Damp Conditions.

Keep Product Surfaces Clean and Dry.

The BT-611M was designed to meet the requirements with compliance European Council Directive (2004/108/EC) and conformity with IEC 60950-1:2001.

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Table of contents

1. Introduction …… 5
2. Measurements review……. 5
3. Specification…… 5
4. Measuring Accuracy…….. 8
5. Principles of operation …… 9
6. Recommended methods for beacon testing …… 10
7. Measuring procedures…… 11
8. Calibration procedure for power measurement……. 33
9. Annual verification …… 35
10. Fault removal ……. 35
11. General information…… 36
Annex 1 The results of testing simulated signals 37

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1 Introduction

The BT-611M is designed mainly for precise measuring signal parameters of 406 MHz Emergency beacons, which are critical to the COSPAS-SARSAT System.

It also provides possibilities to test homing transmitter signal at 121.5 MHz.

The measuring accuracy complies with COSPAS-SARSAT document T.007.

The instrument fully controlled by host PC running WIDOWSXP or later via USB port. It is need also to have installed Internet explorer 6 or higher version.

Provisions made for internal test using digital simulators of 406 MHz and 121.5 MHz signals.

The instrument provides high stability measuring results at laboratory or field condition at ambient temperature of +10°C …40°C. Annual calibration recommended to keep accurate power measuring.

Main units of the instrument are manufactured under Russian patent.

2 Measurements review.

Reliable decoding of 406 MHz beacon signal and position location by COSPAS-SARSAT System depends firstly on phase modulation quality and medium/short frequency stability of beacon's reference oscillator. As a rule, these tests require using optional equipment in addition to standard measuring instruments. The BT-611M provides testing of all emergency beacon basic parameters being connected to host PC only.

In the process of measuring the BT-611M acquires instantaneous amplitude and frequency counts of measured signal. Then required parameters calculated and organized in the form of graphs or tables. It also presents decoded distress message as a whole, so as separated to appropriate fields.

The results may also be saved for further displaying and printing.

3 Specification.

Front panel connectors and indicators

"BEACON" BNC connector - RF power input for 406 MHz and 121.5 MHz signals supplied directly from beacon's power amplifier:

- Maximum power level < 10 W;
- Input impedance 50 Ohm , VSWR< 1,25 up to 450 MHz.

"ANTENNA" TNC connector – RF power input for antenna signals measuring:

- Maximum power level < 200 mW;
- Input impedance 50 Ohm , VSWR< 1,5.

Warning! The unit may be permanently damaged in the case of direct beacon connection to ANTENNA input

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"USB" - connection to host computer.

Front panel LEDs indicates next conditions:

- **ON** - power on;
- **MEAS** – the121.5 MHz signal data acquisition;
- **SIGN –** the 406 MHz signal data acquisition
- **LINK** - transition of data to computer for calculation;

Rear panel elements

- **AC power three-prong connector equipped with 2A fuse**.
- Input voltage 100 V...240V,
- Frequency 47 Hz...63Hz,
- Power consumption 40 W maximum.

Always use the three-prong AC power cord, supplied with this instrument.

- **Ground screw**. Must be connected to the earth ground, when three- to two-prong power line adapter is used.
- **Sweep-tone level regulator.**

Operating environment

- Operating temperature + 10°C...40°C;
- Relative humidity up to 95% at 25°C.

Storage conditions

- Temperature - 40°C... 50°C;
- Humidity up to 90% at 25°C (non condensing)

Weight

- Net 2.8 kg; (measuring unit)
- Gross 3.6 kg (antenna included)

Dimensions

- Measuring unit 252 x 260 x 69 mm
- Antenna (when assembled): Height 280 mm
  Diameter 260 mm

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Figure 1 BT-611M with antenna

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4 Measuring accuracy

4.1 With direct beacon connection, BT-611M provides next accuracy characteristics:

Таблица 1

Measured Parameter limiting error		Measured value	Error	
			C-S T. 008	BT-611M
Frequency	406 MHz	406000… 406100 kHz	±100 Гц	$\Delta_{406} = \pm 20.3$ Hz
	121.5 MHz	121495… 121505 kHz	-	$\Delta_{121} = \pm 21.6$ Hz
Frequency stability measuring resolution		<1x10^{-9}	1x10^{-10}	$\delta_{FS} = +3{,}88 \times 10^{-11}$
Phase deviation		±(63±6.3)°	±2.3°	$\Delta_{\Phi} = \pm 0.8°$
Deviation Trise/Tfall time		150±100 μs	±25 μs	$\Delta_{\tau} = \pm 10$ μs
Asymmetry		< 5%	±1%	$\delta_{AS} = \pm 0.8\%$
Bit rate		400±4 bit/s	±0.6 bit/s	$\Delta_{BR} = \pm 0.18$ bit/s
Burst duration		(440±4,4) ms (520±5.2) ms	±1 ms	$\Delta_{BD} = -80$ μs
Preamble duration limiting error		(160±1,6)ms	±1 ms	$\Delta_{PD} = -60$ μs
Burst repetition period		47.5…54.5 s	±10ms	$\Delta_{RP} = \pm 10$ ms
Input power 406 MHz		3.1…8 W	±10%	$\delta_{P\,406} = \pm 10\%$
406 MHz power rise time		5 ms	±0.5 ms	$\Delta_{PR} = \pm 0.5$ ms
Input power 121.5 MHz		20 mW …150 mW	-	$\delta_{M\,121} = \pm 10\%$

Note: the accuracy of parameters related to Power not warranted for measurements with antenna. The accuracy of other parameters not effected if measured with antenna.

4.2 Power rise time measuring conditions differ in BT-611M relative to C-S recommendations.

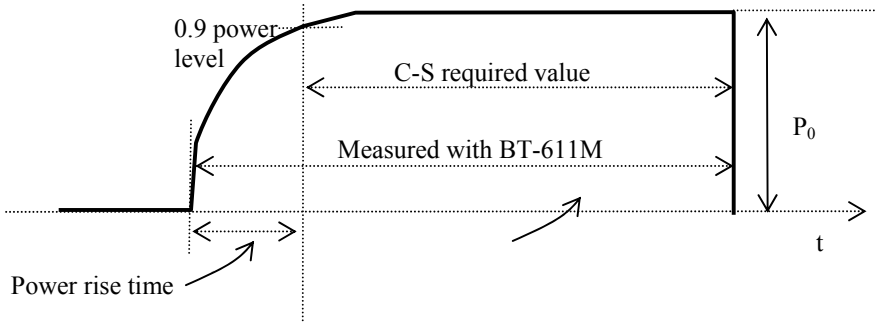

Figure 2 – the difference between BT-611M and C-S recommended method for burst/preamble duration measurements

Figure 2 shows the difference. Since power rise time at most of the beacons less then 1ms BT-611M results remains close to required by C-S method. If measured value exceeds 1 ms,

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one can get corrected preamble and burst duration value by subtracting power rise time from there measured values. For controversial situation, the mentioned values should be measured using spectrum analyzer in zero span mode.

4.3 For 121.5 MHz signal sweep tone modulation parameters additionally estimated

Parameter	**Estimated value**	**error**
Minimum and maximum sweep tone frequencies	100 Hz …1600 Hz	± 20 %
Modulation index	>50%	±30%

These parameters are optional and not calibrated.

5 Principles of operation

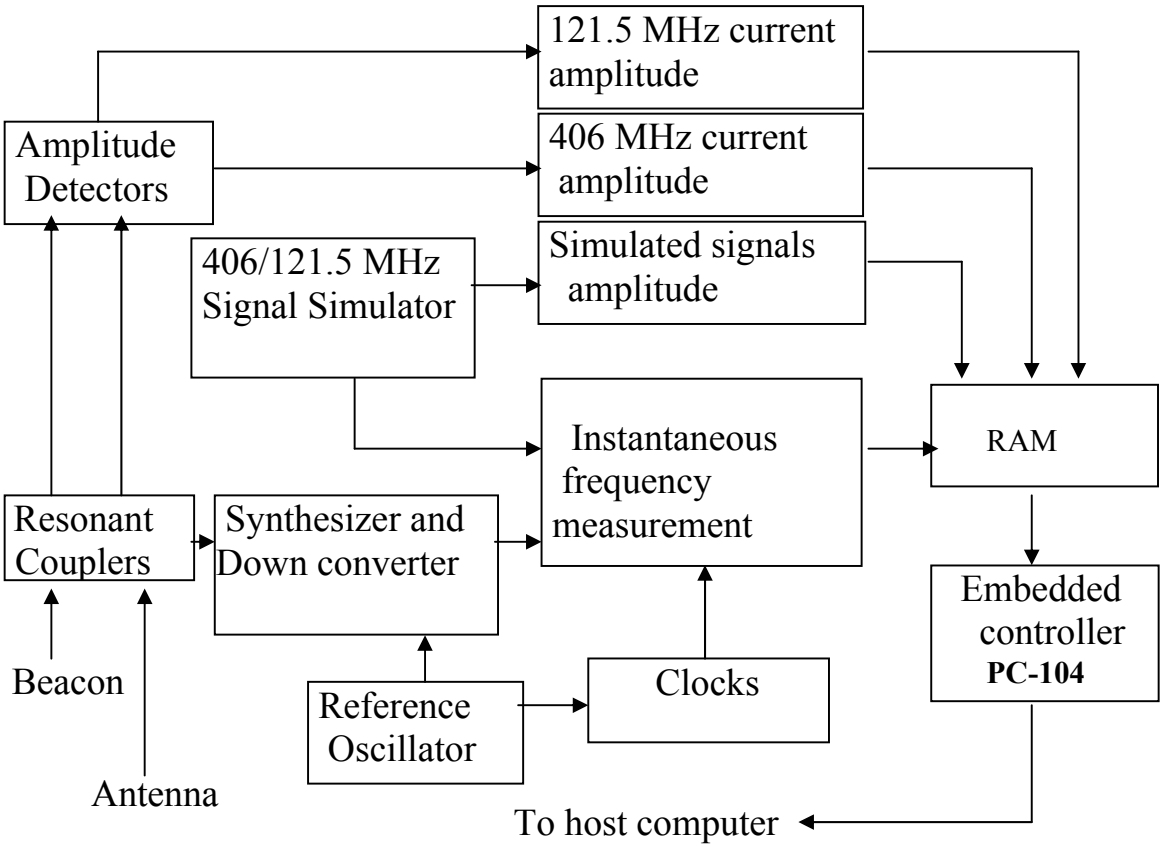

Figure 3 – block diagram of measuring unit

Figure 2 shows the main blocks of signal processing in BT-611M.

For measuring amplitude, the signals first selected by resonant couplers, then after peak detector sampled at DAC. Decoupled RF signals down converted to 100 kHz, then instantaneous

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frequency value measured. The amplitude and frequency samples processed by embedded controller PC-104 to provide raw results which transmitted to host PC. At the PC, the results organized to graphs and tables.

6 Recommended methods for beacon testing.

6.1 Beacon power output directly connected to the instrument.

The best way to have reliable power readings is to connect BT-611M RF power input with supplied cable to the beacon antenna output using a suitable adapter. If you are well familiar about beacon design, it is possible to connect the instrument to power amplifier or the duplexer output inside the beacon. (Be sure that there is no DC voltage at this point!).

6.2 Radiated signal test

Radiated signals of any beacon models can be tested with measuring antenna in the field so as in the laboratory. Reliable power readings not provided with simple antennas, but the measuring results for other parameters not effected at that. In any case, the test with antenna is always preferable because it makes possible to estimate stability of signal generation technique in real environment. It is need to take into account, that with output power degradation twice and more, the beacon still has a chance to be detected by satellite. At the same time beacon's signal may not be processed properly, if modulation index changes more than ±10 degree to nominal value or a bit rate deviate more then 5%.

To prepare measurements with antenna:

- Connect antenna rod to the upper side of the holder;
- Fix the legs by screwing them to the bottom of holder;
- Put assembled antenna on the upper surface of the instrument (or other convenient place) and connect antenna cable to BT-611M antenna input.

Beacon under test should be situated at a distance about 1 m...3 m. Try to avoid vertical metal planes at the same distance.

Note: some EPIRB models (maritime beacons) may have a problem with modulation index or frequency if they radiate without a ground plane, which should simulate water surface. It means they could be used only being submerged to the water. It is recommended to consult beacon manufacturer about proper radiating conditions, if incorrect phase modulation index or frequency value will be revealed at the test. However, the most of them will work properly being placed on the metal plane about 1 m^2.

WORNING! It is strictly prohibited to radiate false distress signals!

Use screened room if available (under deck premises, for example). If not, consult to your nearest COSPAS/SARSAT Local User Terminal specialists about time schedule of the satellite passes over your location.

Do the tests only if satellite is out of view.

It is possible in any time to radiate shortly beacon signals having the self-test mode protocol. To be sure does the beacon test signal fit this protocol, test it first in a screened room. The headline of any protocols, graphics or tables, presents beacon message contents. It will be marked as "Test massage" if beacon actually radiates in a self-test protocol mode.

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7 Measuring procedures

IMPORTANT

- Make sure the available AC power line meets the following requirements: AC 110 or 220 V, frequency 47 Hz...63 Hz;
- Verify that the power source outlet provides appropriate ground contact;
- It is recommended to connect BT-611M to PC serial port first, before the equipment will be connected to the mains or grounded;
- The instrument and supplied RF cable are matched set. Power-measuring channel calibration need if you change cable length or use additional matching devices, more suitable for your conditions (see paragraph 8);
- There are no serviceable parts inside.

7.1 User software

The host PC should run WINDOWS XP and has installed **Internet Explorer** 6 version or later. The software contains the next modules:

Name	**Used as:**
Driver.rar	USB driver is for EPIRB tester
bt03.exe	Main executive module.
bt.url	Web-page shortcut, used to start web page, if module bt03.exe already run but web page was closed.
Calibr1(S/N).406, Calibr1(S/N).121	Manufacturer's Power Calibration files (for supplied cable only)
DATA	The folder for automatically saved data

For installation

- Copy all files to any directory you appointed for beacon tester. The number of copies not limited.;
- Connect the controller USB cable to the PC USB. The operating system detects the new device and starts the "Found New Hardware Wizard". In the window that appears to offer connection to Windows Update site, select "No, not this time" and click "Next>"
- Select "Install from specific location" and click "Next>".
- Specify the path to the driver RX_EPIRB_USB_drv.inf and click "Next>".
- The message about installing the software, which has not been tested for compatibility with the operating system. Click "Continue Anyway".
- To complete the "Found New Hardware Wizard", click "Done".
- Check in Device manager, driver is installed correctly RX_EPIRB_USB_drv.inf and connect the tester to a PC controller and the PC connection is detected.
- Automatically saved files with test results you will find at the DATA directory. You could copy them and run at any PC where **bt03.exe** has been installed, without connecting BT-611M.
- Make backup copy of the CD and store the original in a safety place.

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7.2 Available modes.

After power on, you will hear the short melodious sound and see “ON” indicator is glowing . The instrument is ready to work for short term measurements after 15 minutes. It is recommended to test medium term stability parameters after warming up period of 1 h.

Run the **bt03.exe** software. Below there is a screen you should see (Figure 4 and Figure 5).

The auxiliary MS-DOS program will start in parallel. It has no user data, but it will keep BT-611M running in MEASURE mode even if you close Web Browser or open another window. The BT-611M will continue to collect and store the data, therefore you may see them after returning back to **bt03**. It is recommended to put **bt03.exe.** shortcut at the desktop and save web page in your browser after first loading. To escape fully from measuring you need to close MS-DOS window.

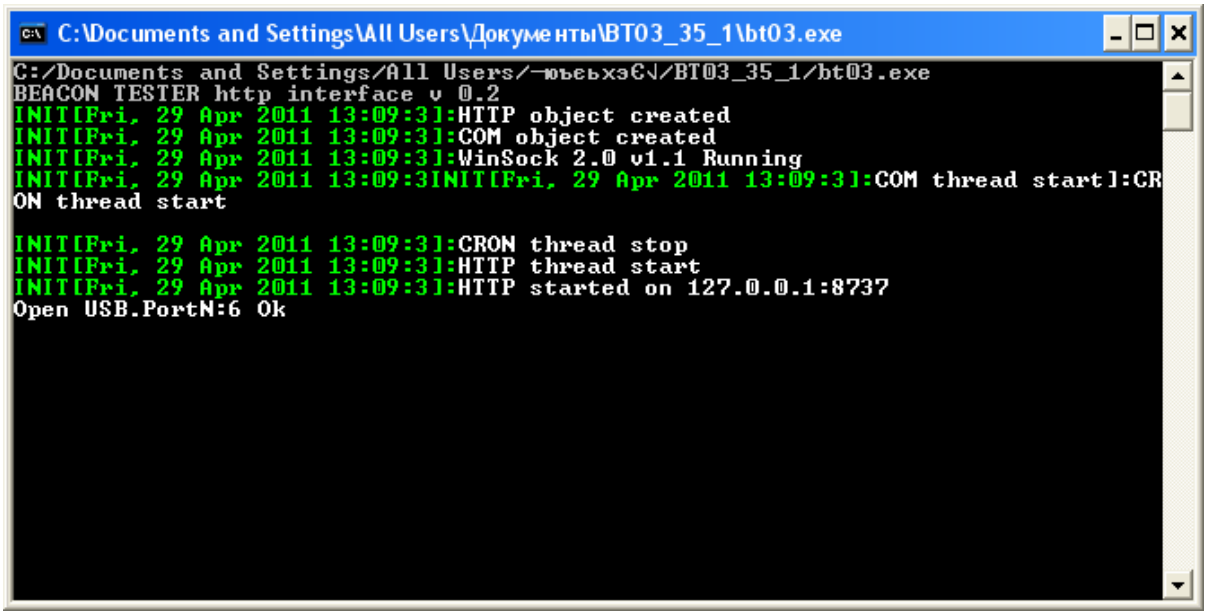
C:\Documents and Settings\All Users\Документы\BT03_35_1\bt03.exe
C:/Documents and Settings/All Users/-ыьъхэЄ√/BT03_35_1/bt03.exe
BEACON TESTER http interface v 0.2
INIT[Fri, 29 Apr 2011 13:09:3]:HTTP object created
INIT[Fri, 29 Apr 2011 13:09:3]:COM object created
INIT[Fri, 29 Apr 2011 13:09:3]:WinSock 2.0 v1.1 Running
INIT[Fri, 29 Apr 2011 13:09:3INIT[Fri, 29 Apr 2011 13:09:3]:COM thread start]:CR
ON thread start
INIT[Fri, 29 Apr 2011 13:09:3]:CRON thread stop
INIT[Fri, 29 Apr 2011 13:09:3]:HTTP thread start
INIT[Fri, 29 Apr 2011 13:09:3]:HTTP started on 127.0.0.1:8737
Open USB.PortN:6 Ok

Figure 4 MS-DOS window.

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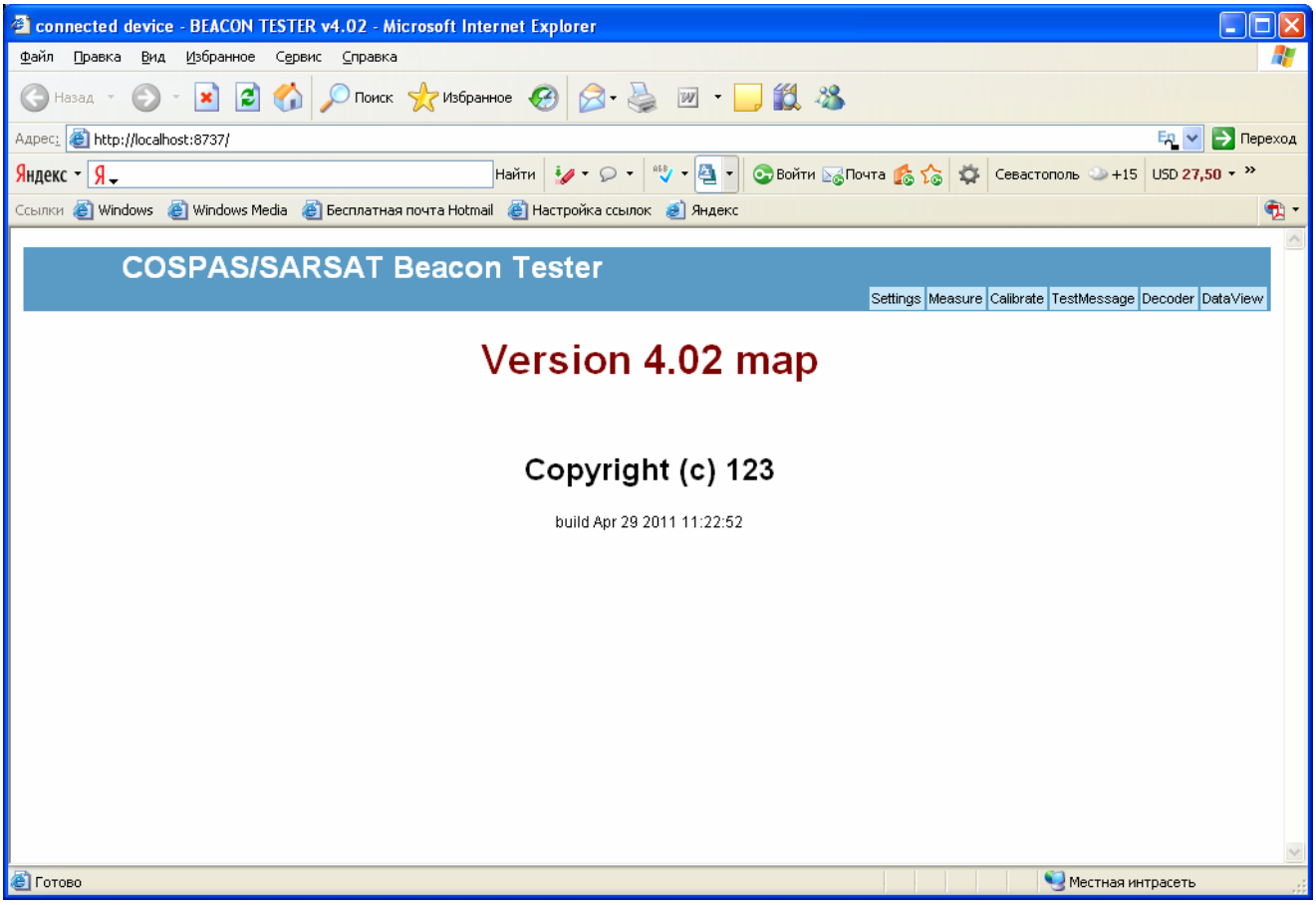
connected device - BEACON TESTER v4.02 - Microsoft Internet Explorer
Файл Правка Вид Избранное Сервис Справка
Назад Поиск Избранное
Адрес: http://localhost:8737/
Переход
Яндекс Найти Войти Почта Севастополь +15 USD 27,50
Ссылки Windows Windows Media Бесплатная почта Hotmail Настройка ссылок Яндекс
COSPAS/SARSAT Beacon Tester
Settings Measure Calibrate TestMessage Decoder DataView
Version 4.02 map
Copyright (c) 123
build Apr 29 2011 11:22:52
Готово
Местная интрасеть

Figure 5 Web-browser window plus Sweep tone from Beacon tester for correct launching.

At the upper line, you may see the next hot keys:

Settings

Opens menu to select:

- **Signal source -** the signal sources you are going to connect: **Beacon, Antenna or Simulator**;
- **Measuring Channels -** the signals you are going to measure**: 406 MHz** only, **121 MHz** only, **or 121+406 MHz;**
- Test conditions, that will be printed at the protocol;
- Start/End time axis, displayed on the graphs ,
- **Checkup time** - (default value 30 minutes) the vertical line on the graphs will mark the time point, after which further monitored parameters should comply with specified values.
- **Power calibration** file numbers linked to the cables (adapters) used;
- File name for **automatic saving** (beac is default name) and the length of data packet (number of bursts), periodically saved to (hard) disk. Selection "0" means no automatic saving.

Click **Apply** key to fix your settings.

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Measure

Opens new window where you may:

- Appoint for printing the test protocol number, date, environment conditions, beacon's model name and serial number;
- Select different forms of results presentation from pull down menu; (default window **406 Phase modulation)**.
- Put the time scale for instantaneous phase
- Put the amplitude scale for instantaneous frequency (applicable for **406 inburst frequency & envelope** only);
- ON/OF screen refresh (**Update ON/Off**);
- Load previously saved file for review (**Load**); you may do it during the measurements, then click **Tester** soft key to return current screen;
- Save manually the results, stored at the moment (**Save**);
- Start measurements (**Run**);

Besides default "**406 Phase modulation"** window, for displaying results you may choose:

- **Medium & short stability** parameters (first results appear after 18 burst passed);
- **406 Phase & Rise/Fall** – averaged modulation index, plus modulation Rise/Fall times for consequently received bursts ;
- **406 Frequency & Power** – averaged burst power, plus frequency, plus RMS frequency deviation (averaged at 18-burst window) for consequently received bursts;
- **Inburst frequency & Envelope -** instantaneous frequency as an increment to mean burst frequency, plus power envelope (available for **406 MHz** channel only)
- **Summary table** - table of 121.5/406 MHz signals parameters and message content
- **121 Message params** - table of 121.5 MHz transmitter parameters.

Calibrate

This key opens the window for calibration 406/121 power measuring channels (see clause 8)

TestMessage

This window provides possibilities to type hex message content (the whole from bit 1 or shortened from bit 26) to see detailed fields content.

Dataview

This window provides detailed viewing of medium/short term stability results by putting convenient vertical and horizontal (time) scales

In **auto** mode new results added automatically after every burst; alternatively they fixed but added with currently stored if you choose **auto** mode again.

Decoder

This window provides decode of EPIRB message content (Figure 14).

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7.3 Recommended procedures.

Make the settings needed in **Settings** menu. It is recommended to select first **Simulator** as a signal source, than:

- Mark **406+121.5 МГц** as **Measuring channels**;
- Choose Power calibration files :
- 1 BT S/N (U10027), for example,
- 2 click **Update calibration file list** → choose **calibr1(U10027).406** and **calibr1(U10027).121** ;
- Mark appropriate USB port (COM * , * - port number is used in PC) ;
- Click **Apply** key then return to **Measure** menu.

The default window for displaying parameters is **406 Phase modulation.**

Click **Run key** to start testing of simulated signals. Figure 7, Figures A.1, Figures A.2a and A.2c in Annex 1 show measuring results. Sweep tone parameters may differ from burst to burst; other parameters should comply with shown ones.

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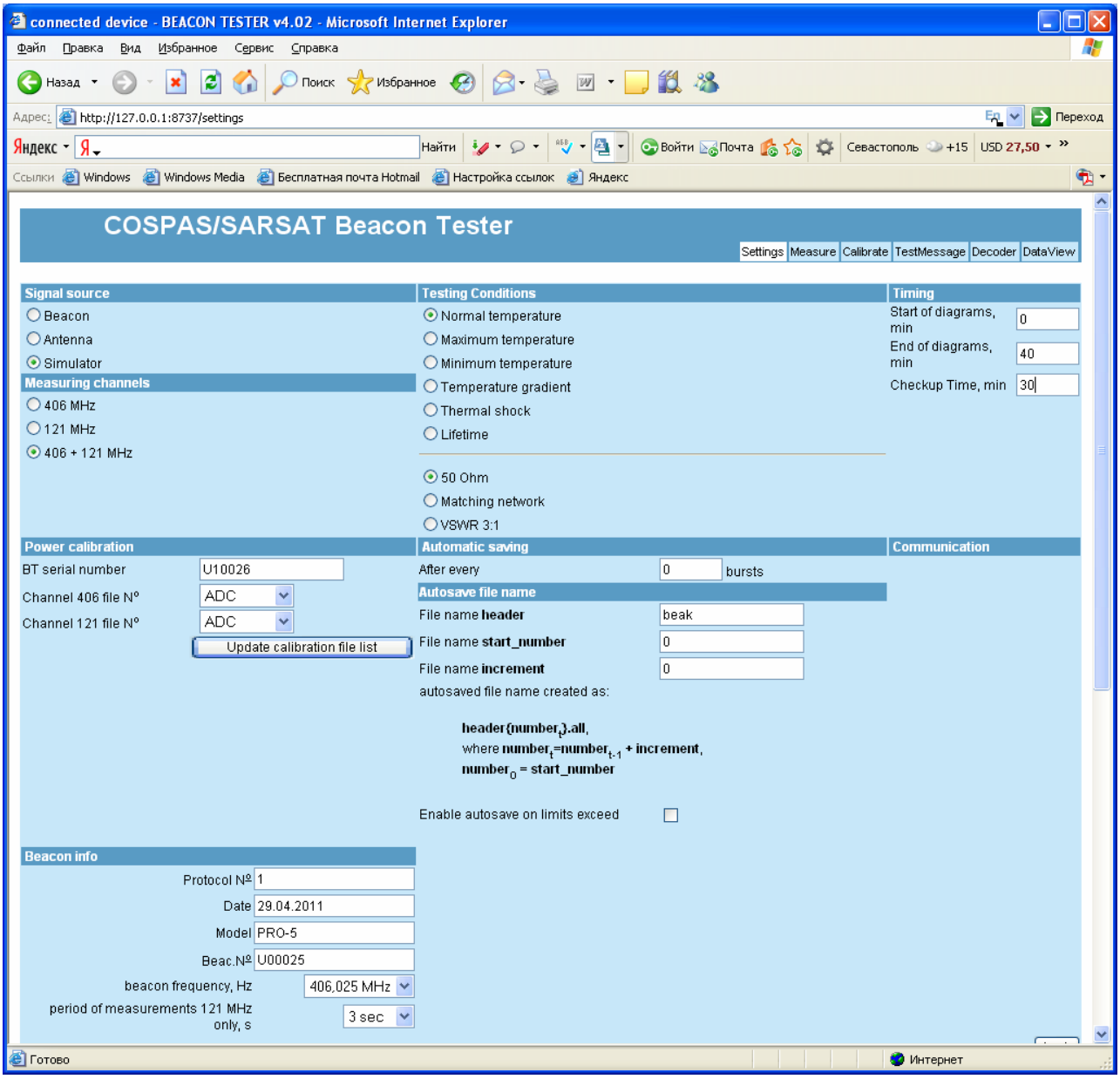

Figure 6 Settings window

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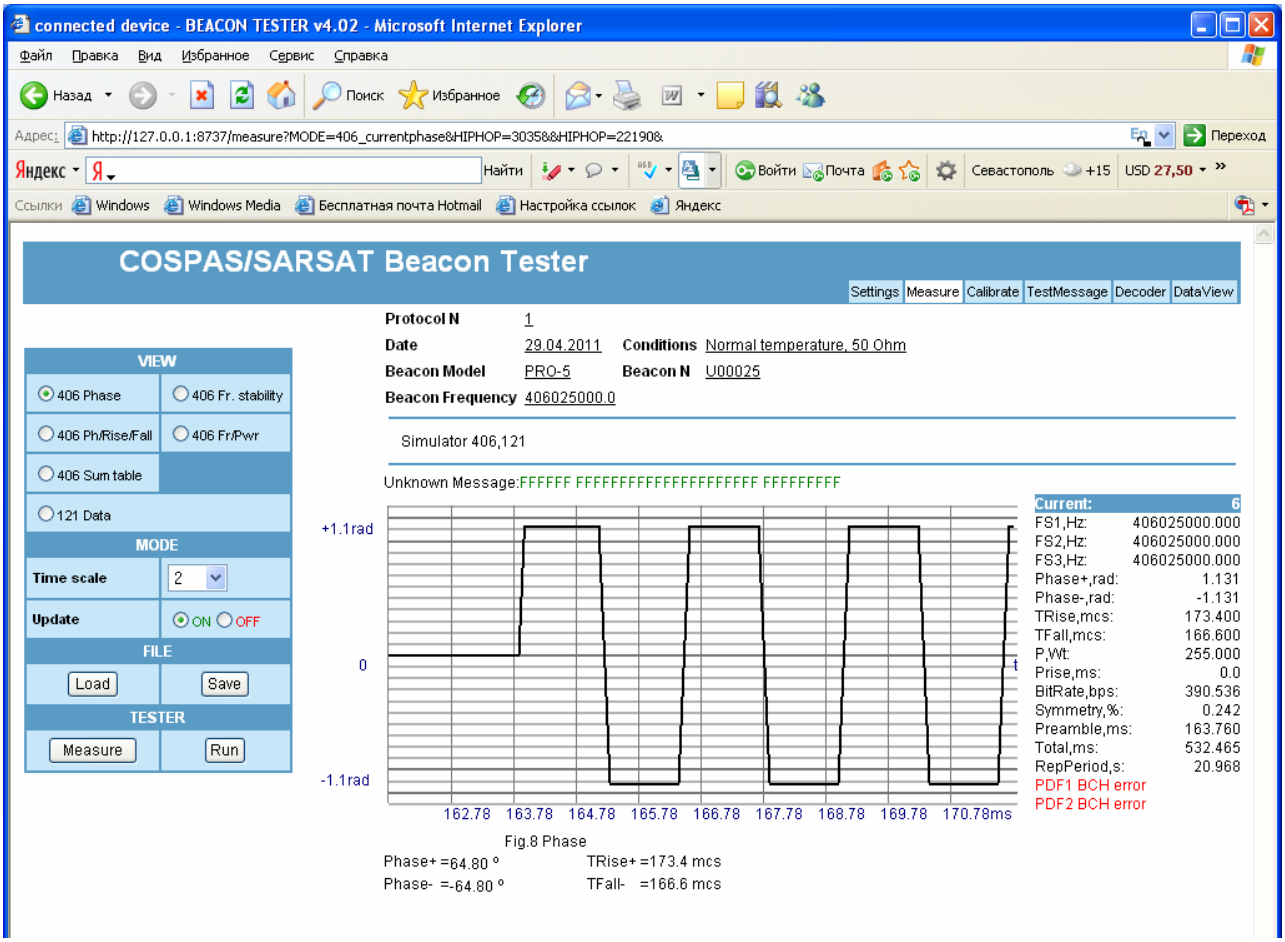

Figure 7 406 Phase window (Simulator)

For measuring beacon's signal parameters:

- return to **Settings** menu (Figure 8);
- choose desired signal source **Beacon** or **Antenna**, and measuring channel: «**121 MHz**» only, or «**406 MHz**» only, or «**406+121.5 MHz**», connect signal source;
- click **Apply** key than **Run** key at **Measure** menu**.** The instrument will display real beacon signal parameters.

If «**406+121.5 MHz**» mode selected the 121.5 MHz signal parameters will be measured ones after every 406 MHz burst, while with «**121 MHz**» only, the measurements will be repeated after 2 s …5 s.

In addition to standard parameters set, selection «**406 MHz**» only channel, makes possible to measure internal burst frequency behavior relative to mean frequency value at **Inburst frequency & Envelope** window.

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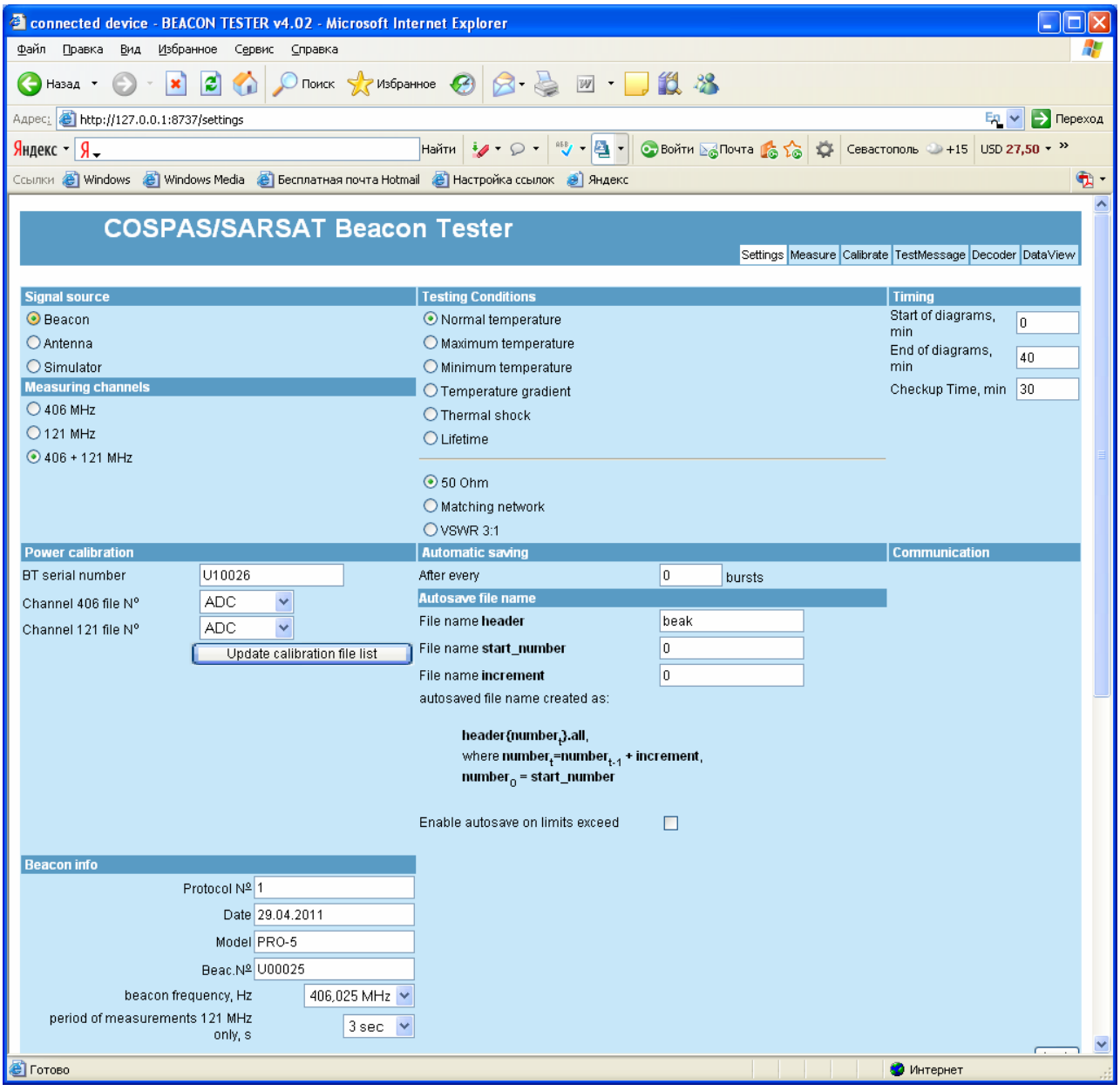

Figure 8 a Settings for Beacon signal measurements

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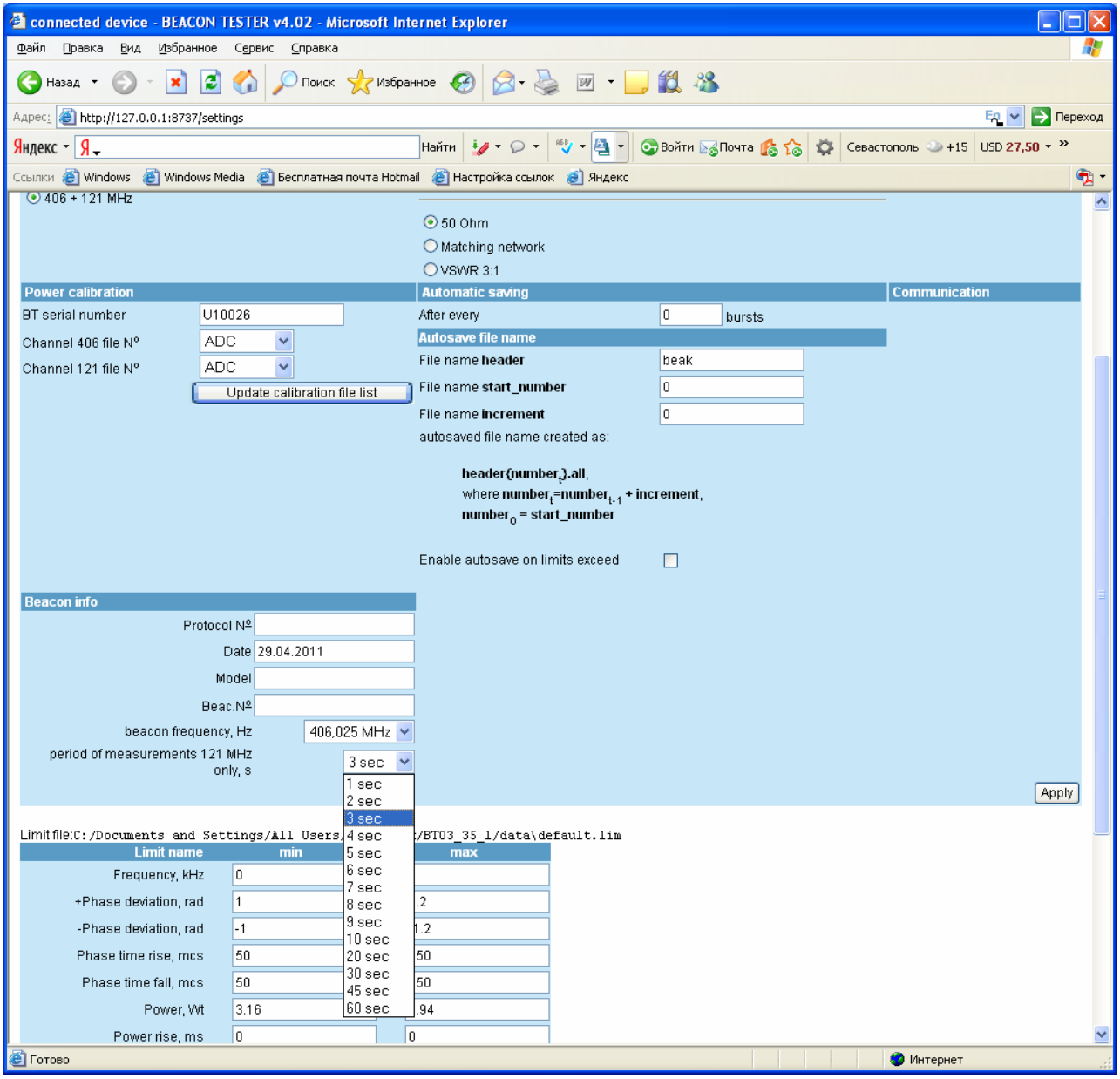

Figure 8 b Settings for Beacon signal measurements

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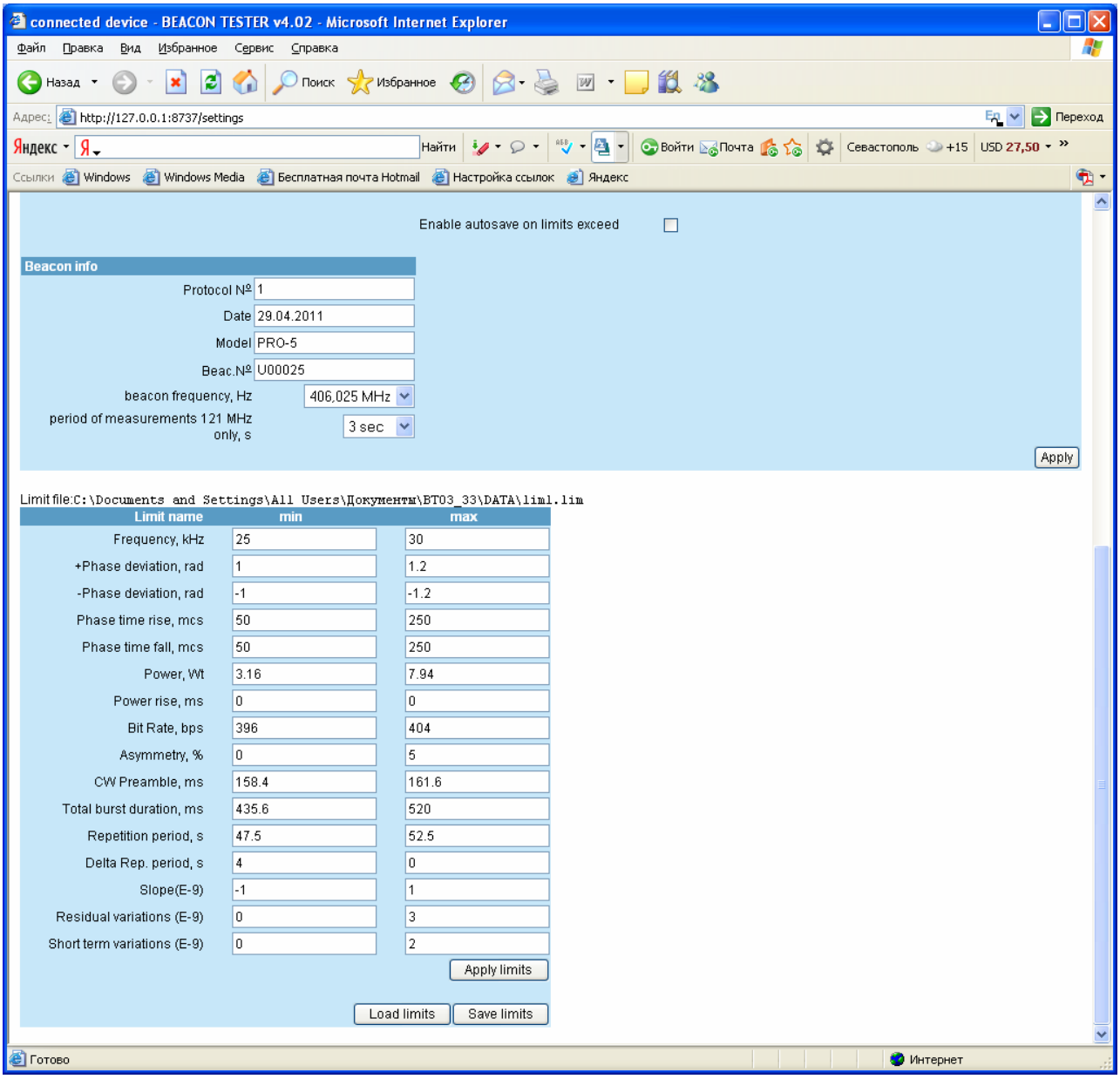
connected device - BEACON TESTER v4.02 - Microsoft Internet Explorer
Файл Правка Вид Избранное Сервис Справка
Назад Поиск Избранное
Адрес: http://127.0.0.1:8737/settings
Переход
Яндекс Найти Войти Почта Севастополь +15 USD 27,50
Ссылки Windows Windows Media Бесплатная почта Hotmail Настройка ссылок Яндекс
Enable autosave on limits exceed
Beacon info
Protocol № 1
Date 29.04.2011
Model PRO-5
Beac.№ U00025
beacon frequency, Hz 406,025 MHz
period of measurements 121 MHz only, s 3 sec
Apply
Limit file:C:\Documents and Settings\All Users\Документы\BT03_33\DATA\liml.lim
Limit name min max
Frequency, kHz 25 30
+Phase deviation, rad 1 1.2
-Phase deviation, rad -1 -1.2
Phase time rise, mcs 50 250
Phase time fall, mcs 50 250
Power, Wt 3.16 7.94
Power rise, ms 0 0
Bit Rate, bps 396 404
Asymmetry, % 0 5
CW Preamble, ms 158.4 161.6
Total burst duration, ms 435.6 520
Repetition period, s 47.5 52.5
Delta Rep. period, s 4 0
Slope(E-9) -1 1
Residual variations (E-9) 0 3
Short term variations (E-9) 0 2
Apply limits
Load limits Save limits
Готово
Интернет

Figure 9 Limit data window

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7.4 Presentation of measured results

Phase modulation It is recommended to use this form for annual Beacon testing. Current phase behavior inside the burst presented to the left. Solid black lines mark the limit levels ± (1.1±0.1) radians. Vertical grid space is 0.1 radian. Other measured burst parameters listed in the column at the right. The meaning of measured values explained at the table 2. Above the phase picture, hexadecimal message of current burst displayed. Averaged over half a bit modulation index (for degree dimension) additionally displayed at the bottom, together with Trise and Tfall readings. The phase picture may be scaled by changing **t** factor from 1 to 100. The Figures 12a through 12g shows differently scaled phase modulation examples of the same burst. Only ones scaled picture may be recalled after saving measuring results.
Current picture at **t** =1..5 may be inclined up or down until the reference oscillator not warmed up. If it remains inclined long time, there may be internal frequency drift during the burst; it is recommended to check Allan variances after 18 bursts in this case.

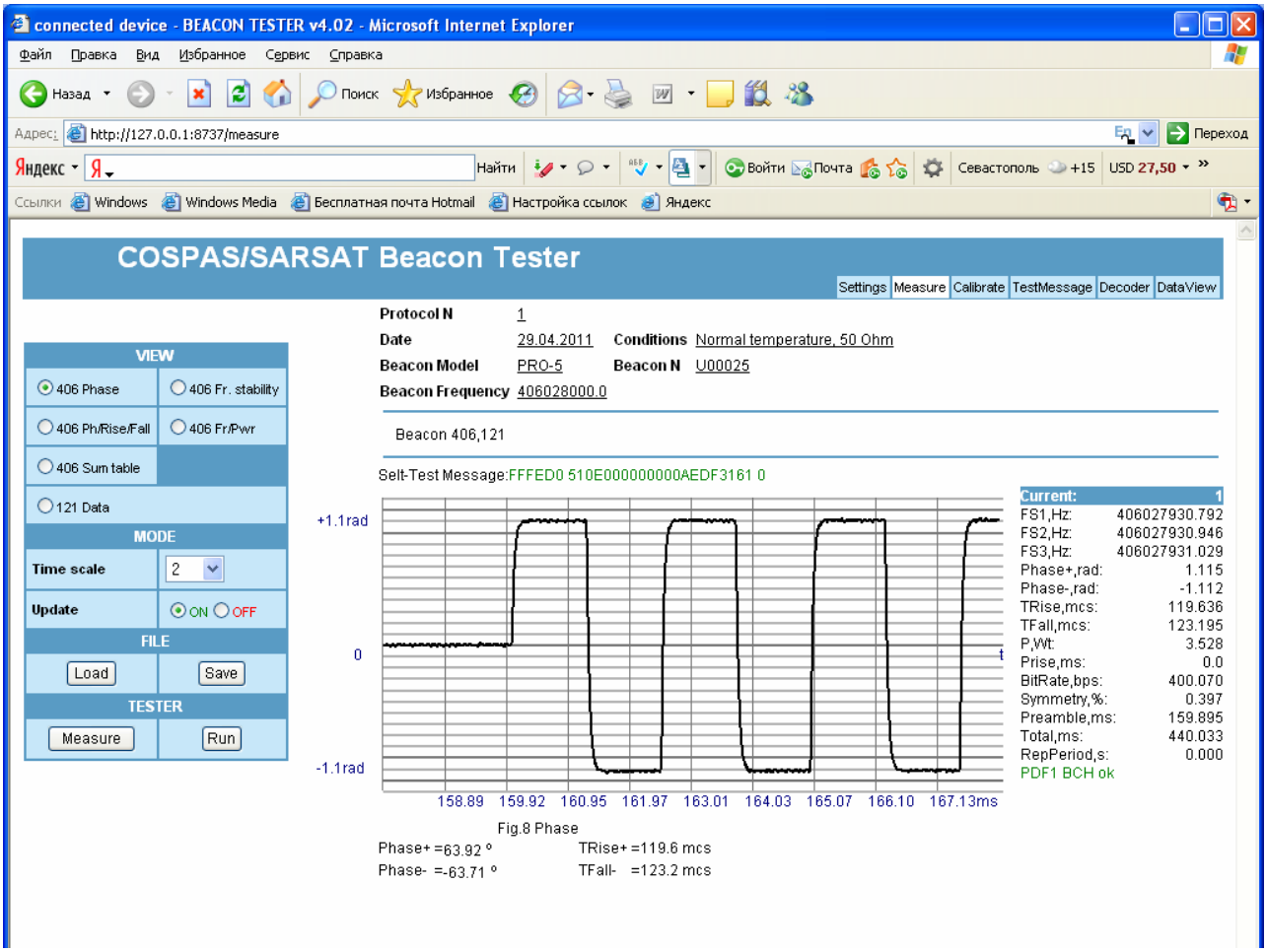

Figure 10 Measured results (406 MHz Phase modulation)

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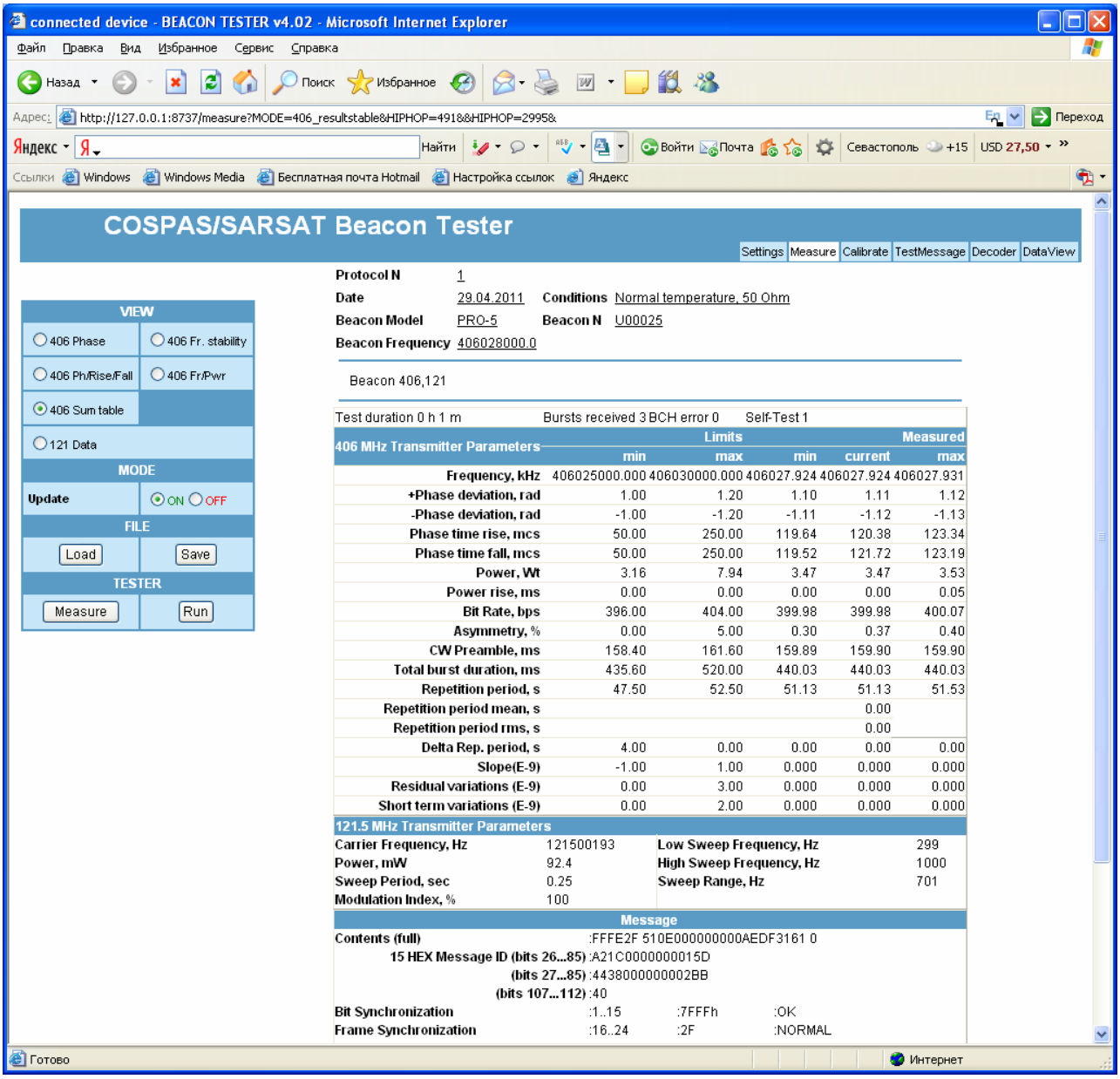
connected device - BEACON TESTER v4.02 - Microsoft Internet Explorer
COSPAS/SARSAT Beacon Tester
Settings
Measure
Calibrate
TestMessage
Decoder
DataView
VIEW
406 Phase
406 Fr. stability
406 Ph/Rise/Fall
406 Fr/Pwr
406 Sum table
121 Data
MODE
Update
ON
OFF
FILE
Load
Save
TESTER
Measure
Run
Protocol N 1
Date 29.04.2011 Conditions Normal temperature, 50 Ohm
Beacon Model PRO-5 Beacon N U00025
Beacon Frequency 406028000.0
Beacon 406,121
Test duration 0 h 1 m Bursts received 3 BCH error 0 Self-Test 1
406 MHz Transmitter Parameters
Limits
Measured
min max min current max
Frequency, kHz 406025000.000 406030000.000 406027.924 406027.924 406027.931
+Phase deviation, rad 1.00 1.20 1.10 1.11 1.12
-Phase deviation, rad -1.00 -1.20 -1.11 -1.12 -1.13
Phase time rise, mcs 50.00 250.00 119.64 120.38 123.34
Phase time fall, mcs 50.00 250.00 119.52 121.72 123.19
Power, Wt 3.16 7.94 3.47 3.47 3.53
Power rise, ms 0.00 0.00 0.00 0.00 0.05
Bit Rate, bps 396.00 404.00 399.98 399.98 400.07
Asymmetry, % 0.00 5.00 0.30 0.37 0.40
CW Preamble, ms 158.40 161.60 159.89 159.90 159.90
Total burst duration, ms 435.60 520.00 440.03 440.03 440.03
Repetition period, s 47.50 52.50 51.13 51.13 51.53
Repetition period mean, s 0.00
Repetition period rms, s 0.00
Delta Rep. period, s 4.00 0.00 0.00 0.00 0.00
Slope(E-9) -1.00 1.00 0.000 0.000 0.000
Residual variations (E-9) 0.00 3.00 0.000 0.000 0.000
Short term variations (E-9) 0.00 2.00 0.000 0.000 0.000
121.5 MHz Transmitter Parameters
Carrier Frequency, Hz 121500193 Low Sweep Frequency, Hz 299
Power, mW 92.4 High Sweep Frequency, Hz 1000
Sweep Period, sec 0.25 Sweep Range, Hz 701
Modulation Index, % 100
Message
Contents (full) :FFFE2F 510E000000000AEDF3161 0
15 HEX Message ID (bits 26...85) :A21C0000000015D
(bits 27...85) :4438000000002BB
(bits 107...112) :40
Bit Synchronization :1..15 :7FFFh :OK
Frame Synchronization :16..24 :2F :NORMAL
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Figure 11 a Measured results (406 Summary table)

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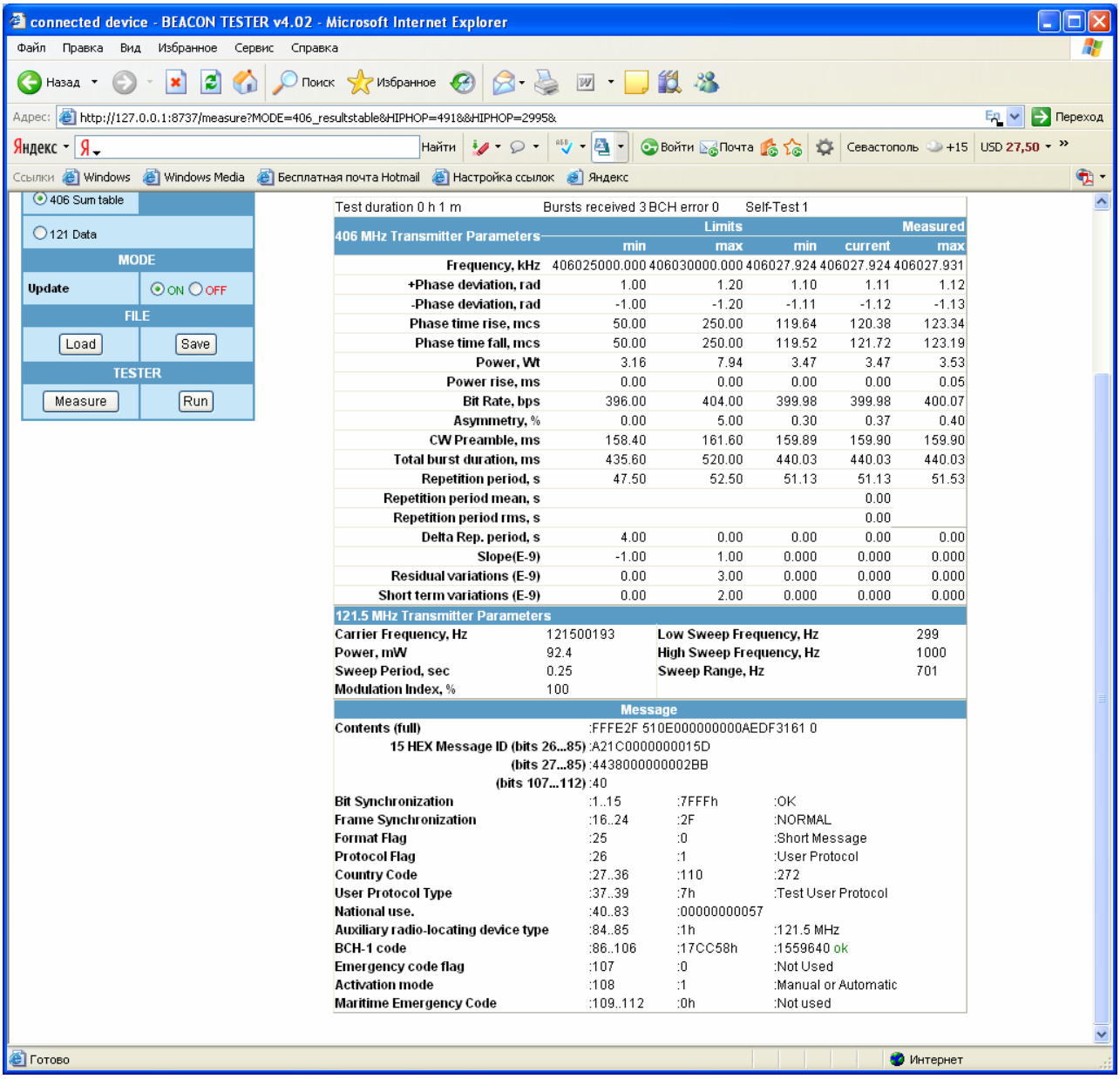
connected device - BEACON TESTER v4.02 - Microsoft Internet Explorer
406 Sum table
121 Data
MODE
Update
ON OFF
FILE
Load
Save
TESTER
Measure
Run
Test duration 0 h 1 m
Bursts received 3 BCH error 0
Self-Test 1
406 MHz Transmitter Parameters
Limits
Measured
min
max
min
current
max
Frequency, kHz 406025000.000 406030000.000 406027.924 406027.924 406027.931
+Phase deviation, rad 1.00 1.20 1.10 1.11 1.12
-Phase deviation, rad -1.00 -1.20 -1.11 -1.12 -1.13
Phase time rise, mcs 50.00 250.00 119.64 120.38 123.34
Phase time fall, mcs 50.00 250.00 119.52 121.72 123.19
Power, Wt 3.16 7.94 3.47 3.47 3.53
Power rise, ms 0.00 0.00 0.00 0.00 0.05
Bit Rate, bps 396.00 404.00 399.98 399.98 400.07
Asymmetry, % 0.00 5.00 0.30 0.37 0.40
CW Preamble, ms 158.40 161.60 159.89 159.90 159.90
Total burst duration, ms 435.60 520.00 440.03 440.03 440.03
Repetition period, s 47.50 52.50 51.13 51.13 51.53
Repetition period mean, s 0.00
Repetition period rms, s 0.00
Delta Rep. period, s 4.00 0.00 0.00 0.00 0.00
Slope(E-9) -1.00 1.00 0.000 0.000 0.000
Residual variations (E-9) 0.00 3.00 0.000 0.000 0.000
Short term variations (E-9) 0.00 2.00 0.000 0.000 0.000
121.5 MHz Transmitter Parameters
Carrier Frequency, Hz 121500193
Power, mW 92.4
Sweep Period, sec 0.25
Modulation Index, % 100
Low Sweep Frequency, Hz 299
High Sweep Frequency, Hz 1000
Sweep Range, Hz 701
Message
Contents (full) :FFFE2F 510E000000000AEDF3161 0
15 HEX Message ID (bits 26...85) :A21C0000000015D
(bits 27...85) :4438000000002BB
(bits 107...112) :40
Bit Synchronization :1..15 :7FFFh :OK
Frame Synchronization :16..24 :2F :NORMAL
Format Flag :25 :0 :Short Message
Protocol Flag :26 :1 :User Protocol
Country Code :27..36 :110 :272
User Protocol Type :37..39 :7h :Test User Protocol
National use. :40..83 :00000000057
Auxiliary radio-locating device type :84..85 :1h :121.5 MHz
BCH-1 code :86..106 :17CC58h :1559640 ok
Emergency code flag :107 :0 :Not Used
Activation mode :108 :1 :Manual or Automatic
Maritime Emergency Code :109..112 :0h :Not used
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Figure 11 b Measured results (406 Summary table continuation)

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Table 2

Current: 3621	Current burst number since the test started
FS1,Hz: 406027430.108	Frequency value sampled on 12....112 ms interval
FS2,Hz: 406027430.168	Frequency value sampled on 217…317 ms interval
FS3,Hz: 406027430.135	Frequency value sampled on 317…417 ms interval
Phase+,rad: 1.107	«+» modulation index (averaged)
Phase-,rad: -1.094	«-»modulation index (averaged)
TRise,mcs: 114.364	Deviation time rise
TFall,mcs: 116.192	Deviation time fall
P,Wt: 6.868	Burst power (averaged at interval from 70 ms to the burst end)
Prise,ms: 0.0	Power rise time (0.1…0.9 level)
BitRate,bps: 399.993	Bit rate
Assymetry,%: 0.000	Half bit asymmetry
Preamble,ms: 159.978	CW preamble
Total,ms: 440.054	Total burst duration
RepPeriod,s: 50.700	Burst repetition period
DifPeriod,s: 3.690	Maximum period difference (over 18 bursts)
Slope: 3.8e-012	Frequency slope relative to carrier (18 FS2 counts window,)
R.variance: 2.5e-010	Residual variations (18 FS2 counts window,)
S.variance: 5.9e-011	Short term stability (Allan variance, corresponds to FS2, FS3 counts)
PDF1 BCH ok	BCH check result

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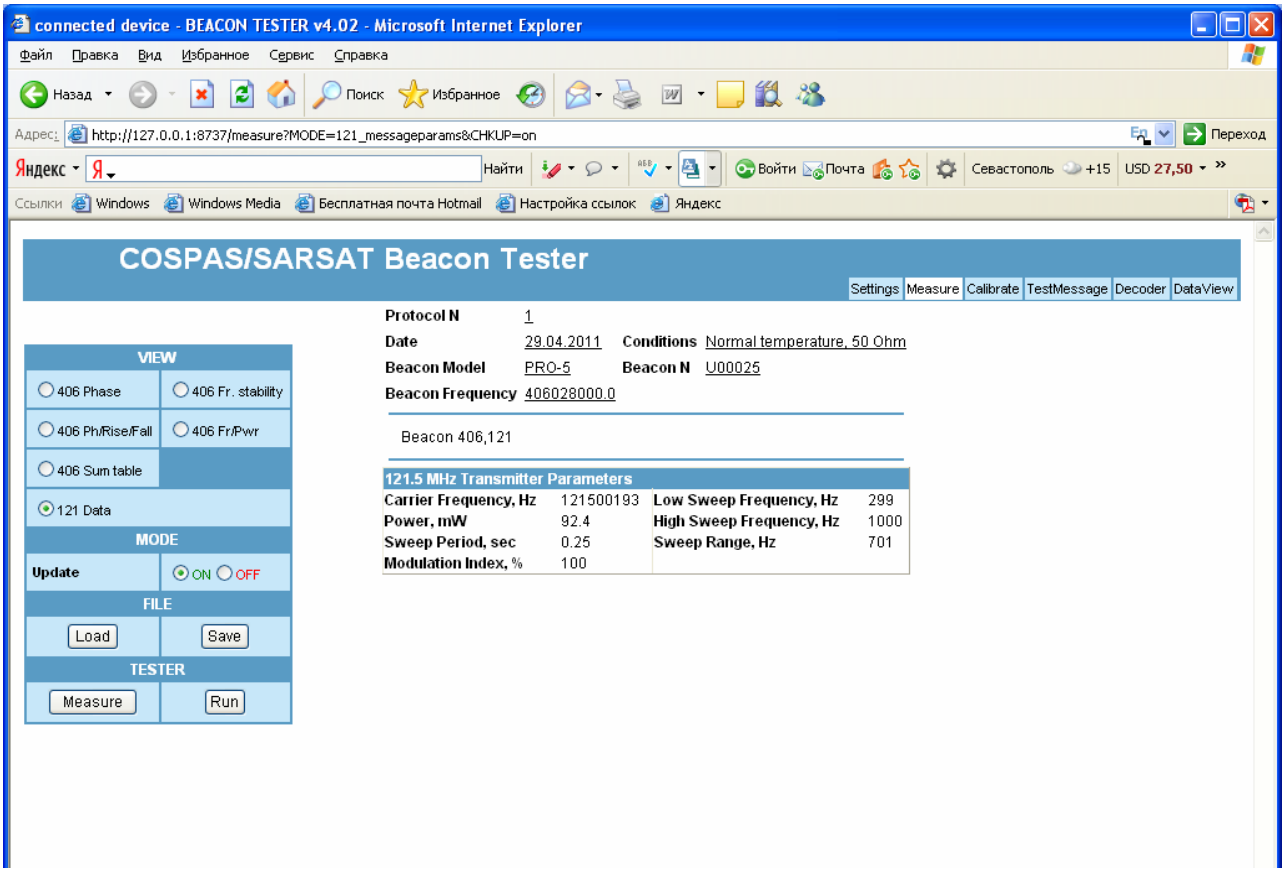

Figure 12 Measured results (121.5 MHz AM)

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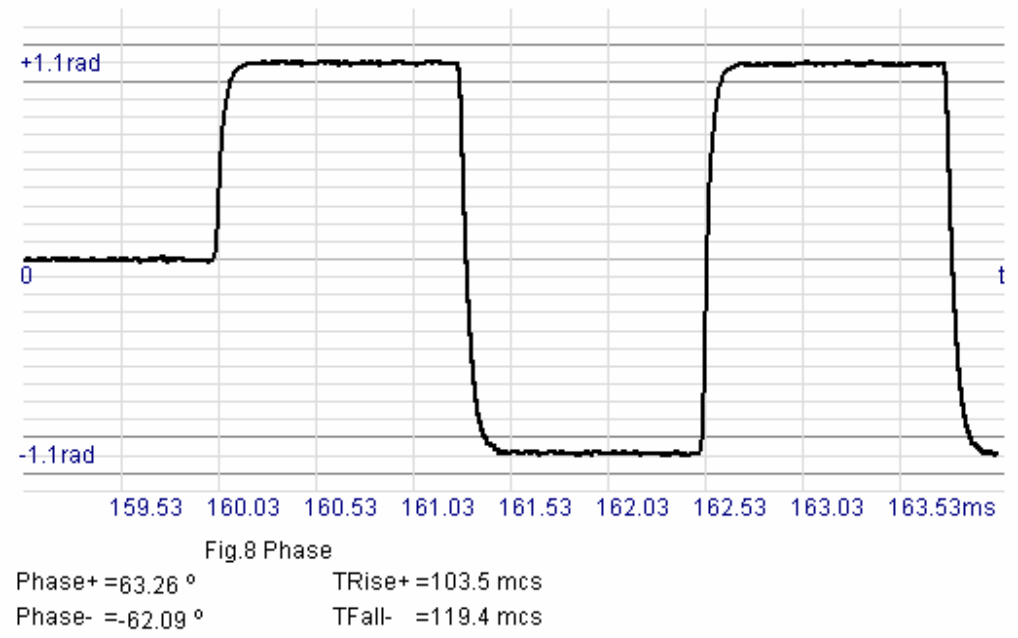

Figure 13a – instantaneous phase, scale 1

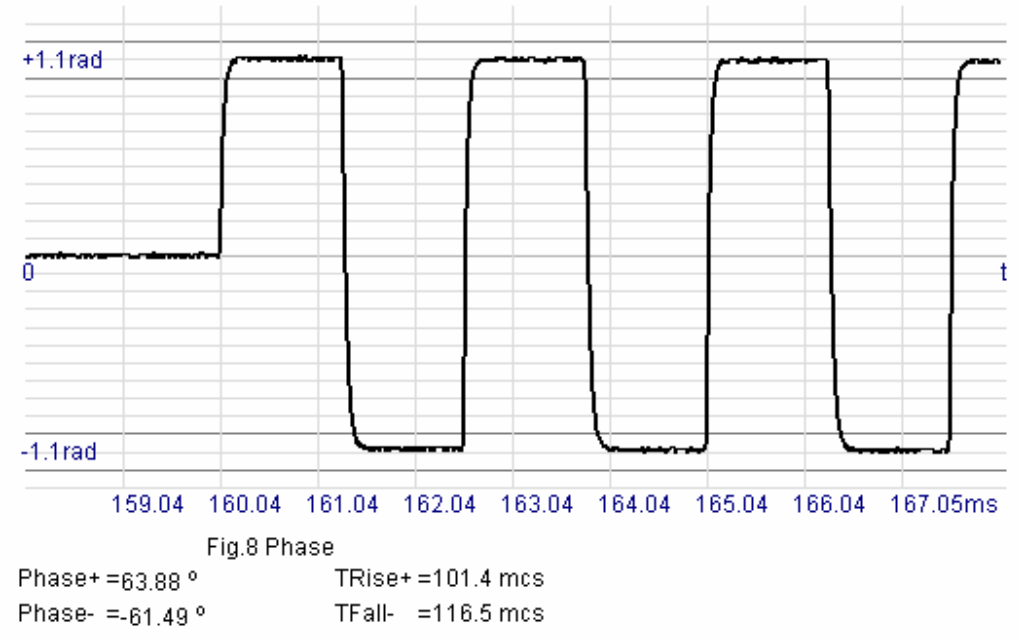

Figure 13b – instantaneous phase, scale 2

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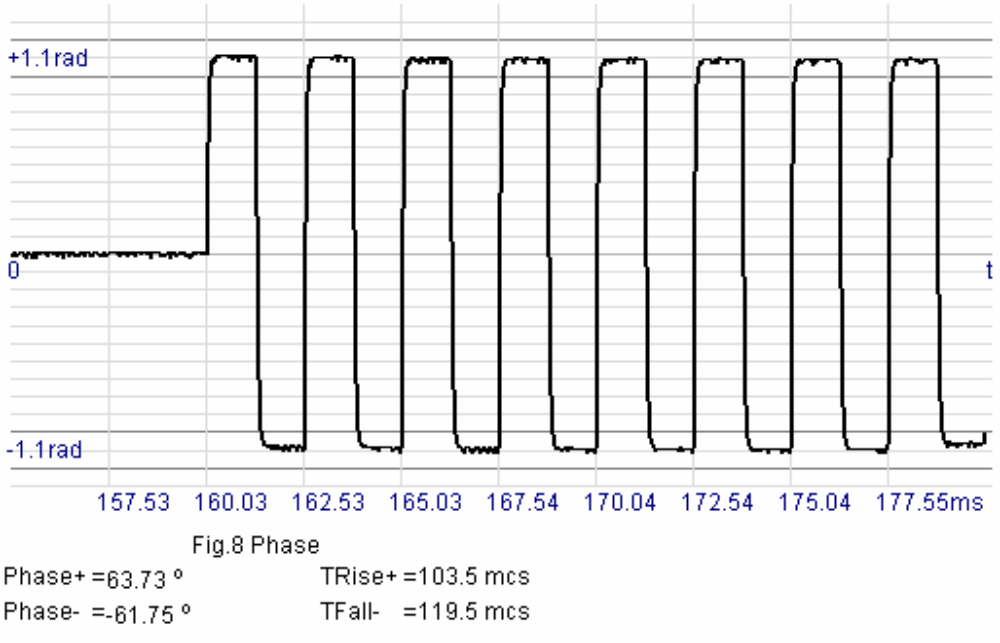

Figure 13c – instantaneous phase, scale 5

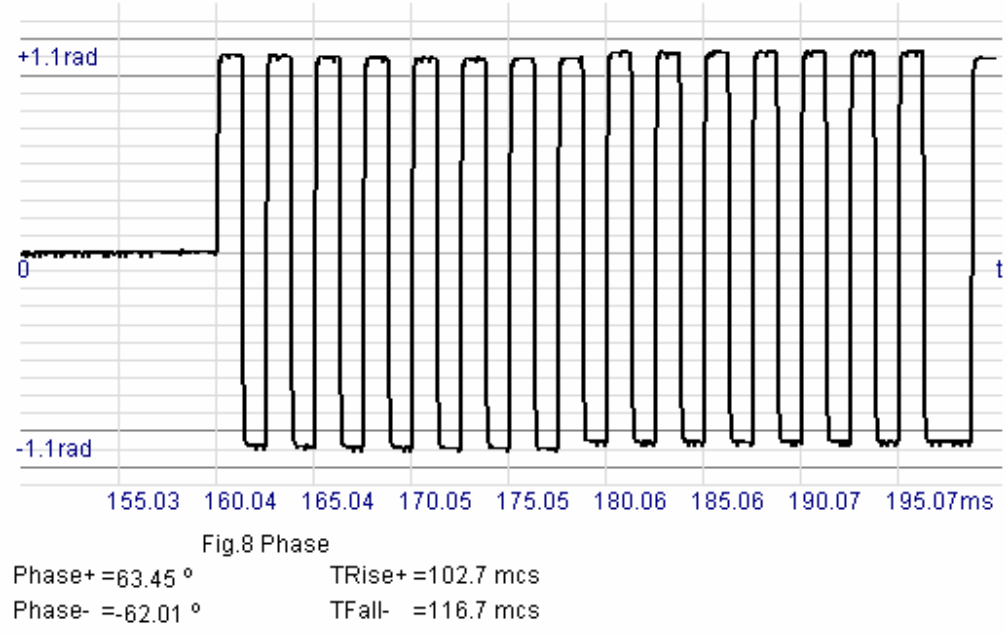

Figure 13d – instantaneous phase, scale 10

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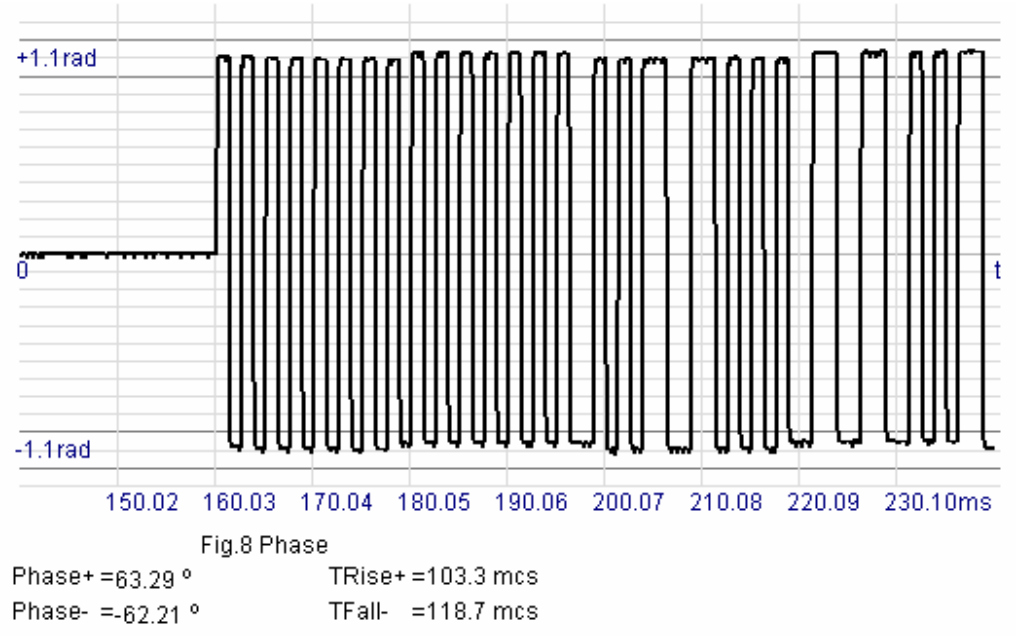

Figure 13e – instantaneous phase, scale 20

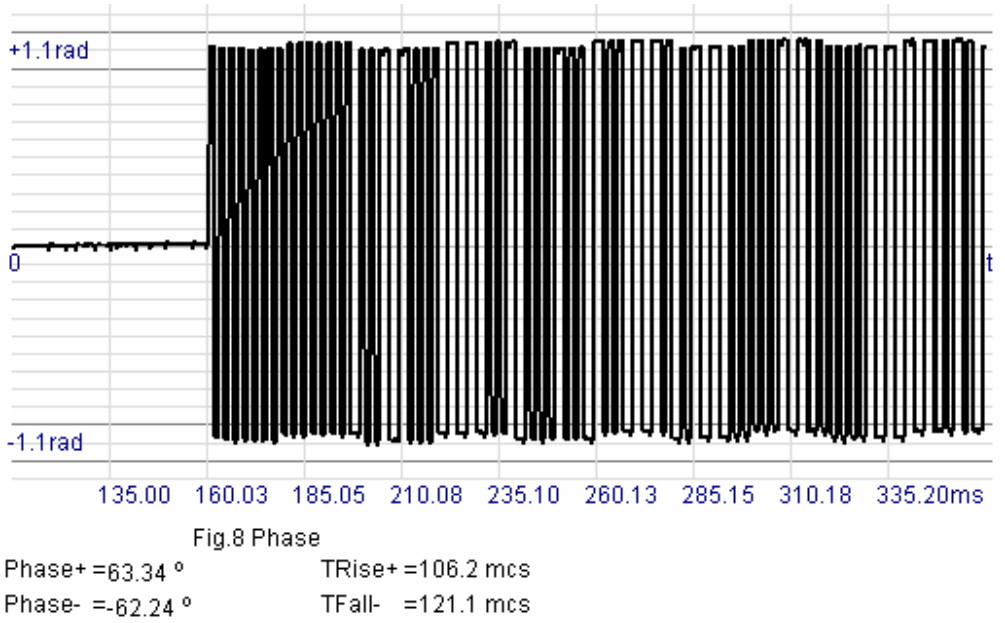

Figure 13f – instantaneous phase, scale 50

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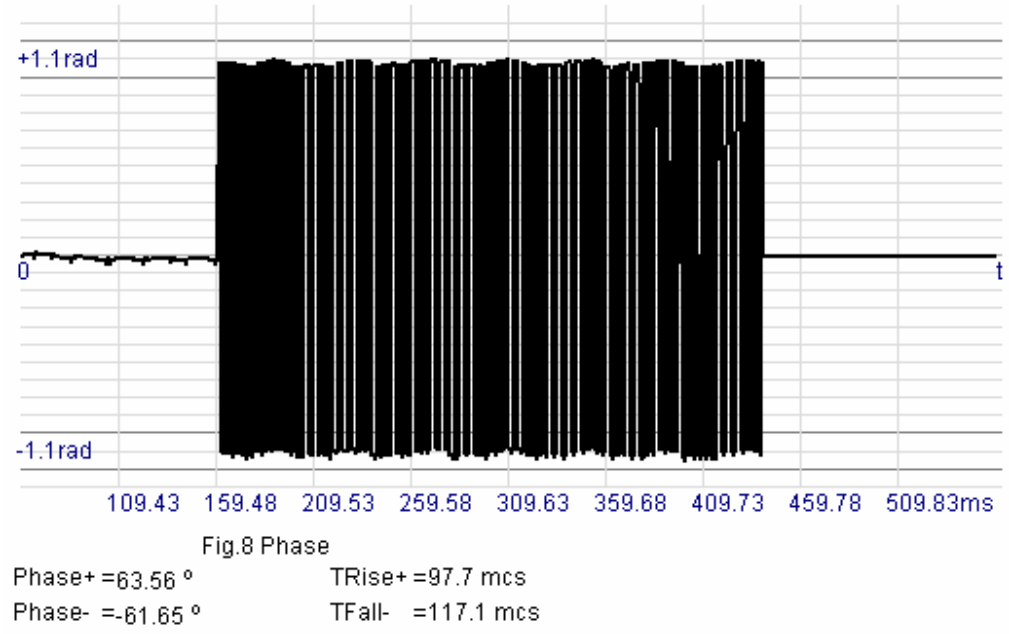

Figure 13g – instantaneous phase, scale 100

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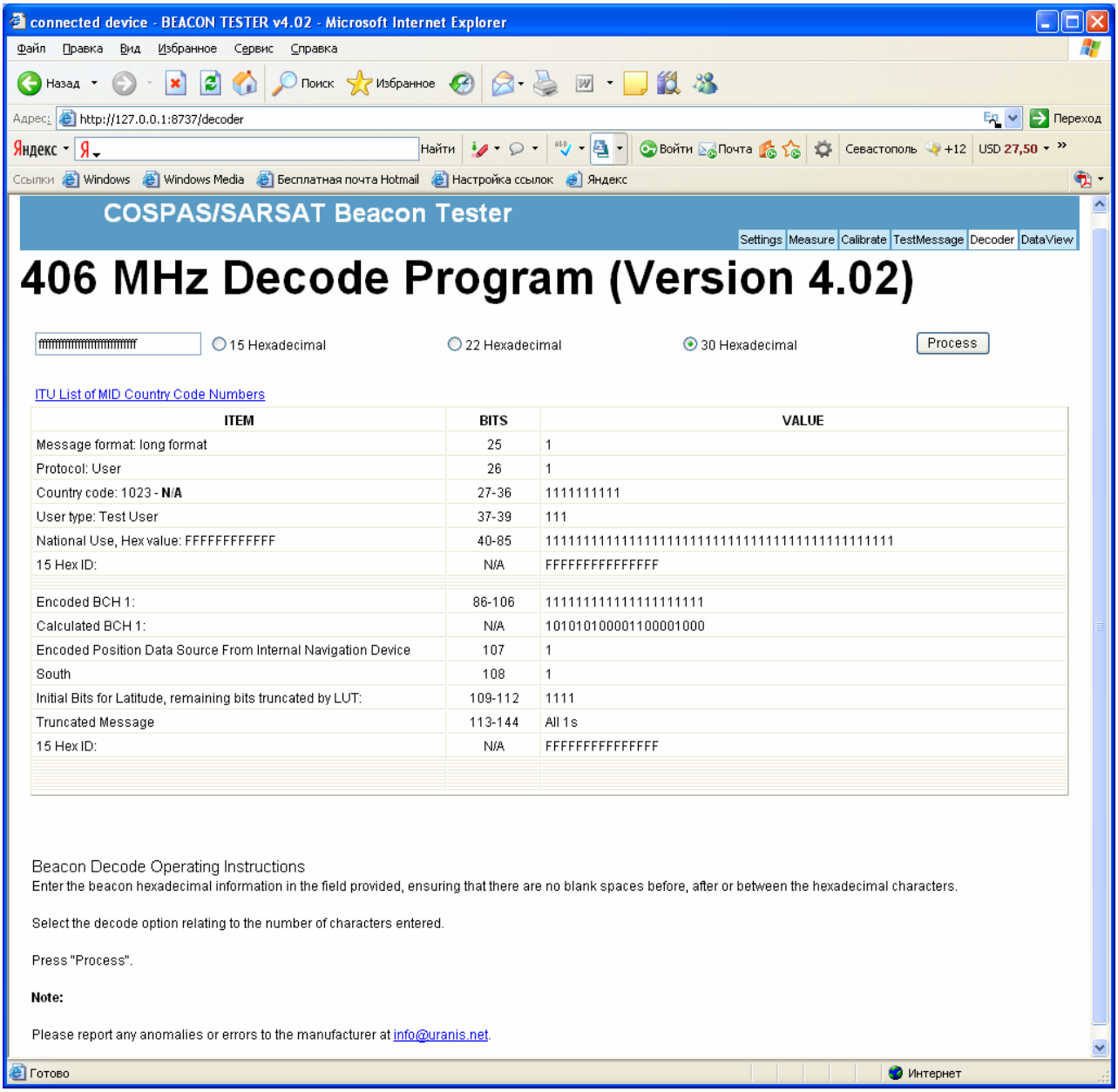

Figure 14 406 MHz Decoder

Medium & short stability window normally used for the transmitted frequency long-term tests. The measurement begins with the Beacon switched on. Vertical line marks the time point after which frequency stability must come to required limits. Default time value is 30 min. It can be changed at the **Settings** window.

There are three parameters used for frequency stability test:

- *The mean slope*, defined as the mean slope of the least-squares straight line; horizontal solid lines marks the limits ±1E-9;
- *The residual frequency variations about that least-squares straight line*; horizontal solid line marks the limit 3E-9;

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- *Short-term frequency stability* corresponds to the Allan variance; horizontal solid line marks the limit 2E-9;

Figure 15 shows the example of results of the transmitted frequency long-term test.

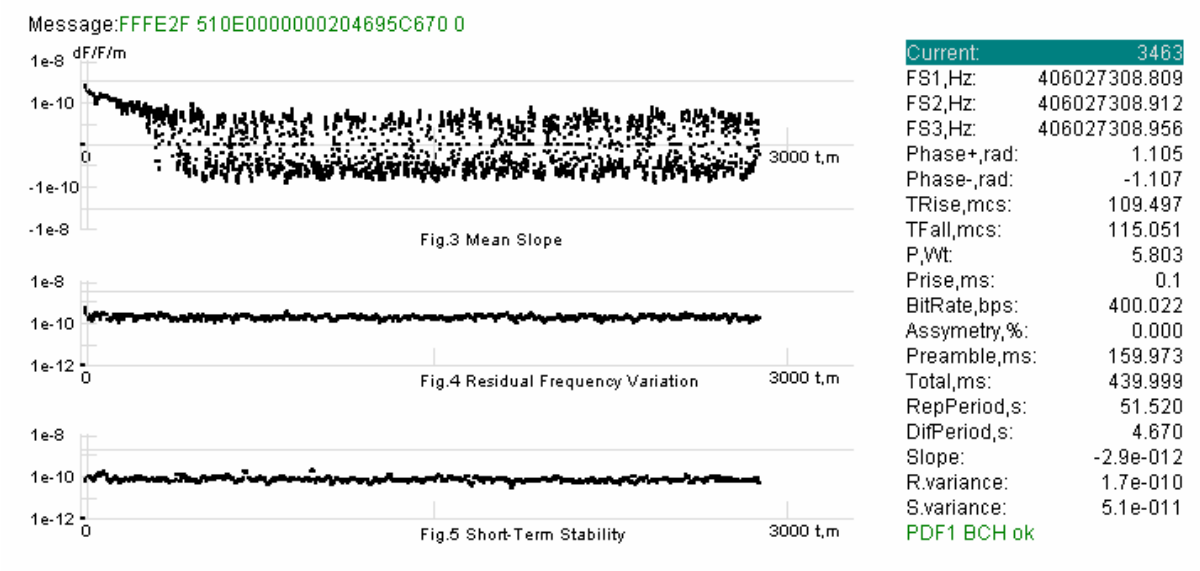

Figure 15 - example of results of the transmitted frequency long-term test

406 Phase & Rise/Fall - displays *Modulation index* and *Rise and Fall Times* data stored over long-term test; normally used to check signal generation and modulation scheme consistency. Figure 16 shows an example of results recorded. Solid horizontal lines mark the limits.

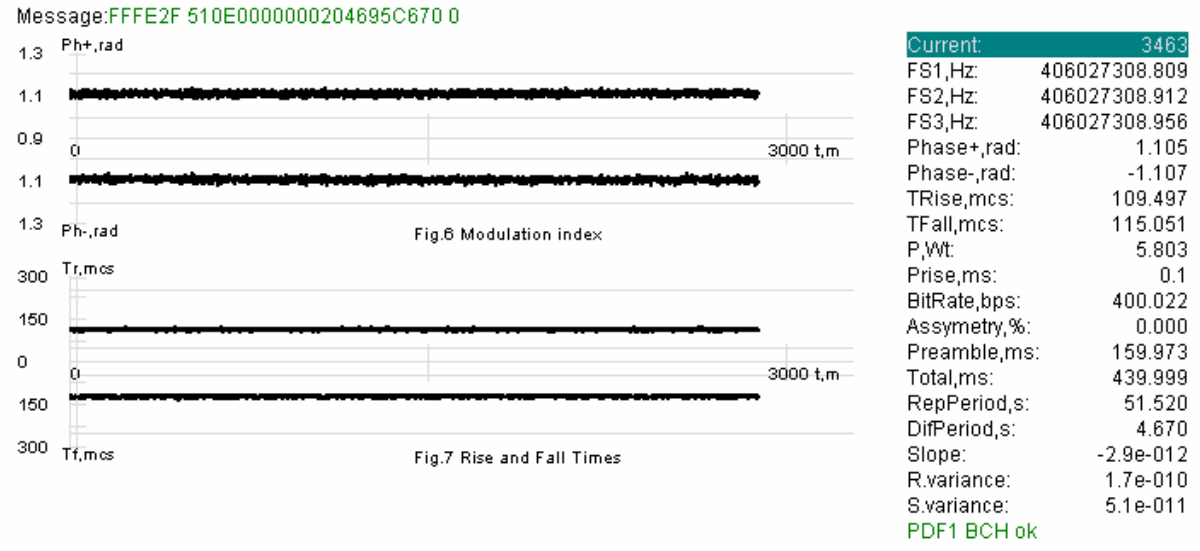

Figure 16 - phase modulation parameters accumulated during long term test

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406 Frequency & power - displays similar results for power and frequency parameters. The third auxiliary graph displays frequency stability in the form of RMS frequency deviation of separate bursts, calculated from 18-burst window containing Fs2 readings.

Summary Table - recommended as the final protocol of Beacon annual test; it includes a set of 121.5 MHz and 406 MHz transmitter's test results. At the bottom of the table, the whole message and separate field's content displayed.

406 Message content и **121.5 MHz parameters –** the window presents tables of 406 MHz message content and 121.5 MHz signal parameters.

406 MHz frequency & envelope - *in-burst frequency* graph displays frequency deviation from mean value inside the burst at 0.1 Hz resolution. This graph recommended for assessment of signal generation schematic quality. Figure 17a shows an example how the power amplifier may effect frequency parasitic oscillating. The Figure 17b provides an example of frequency behavior with stable frequency generating schematic.

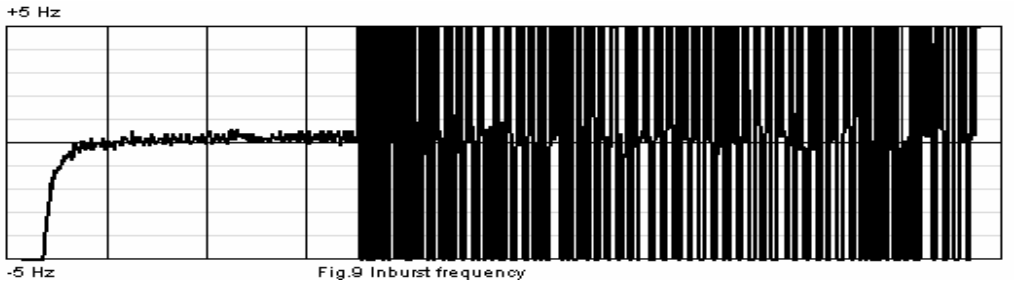

Figure 17a - switching on power amplifier disturbs frequency inside the burst

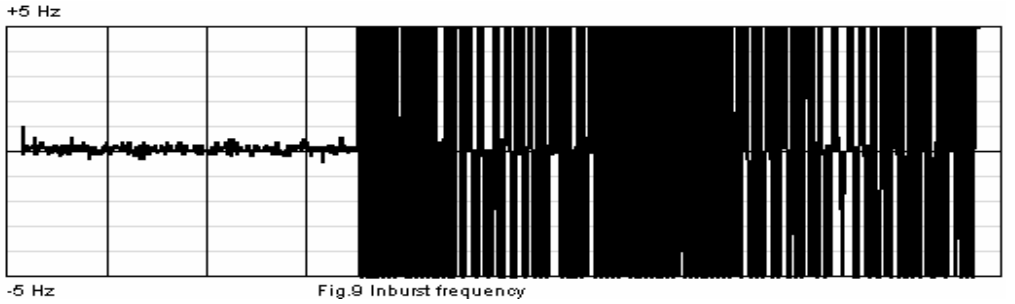

Figure 17b - Power amplifier switching on makes no influence on burst frequency

.

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8 Calibration procedure for POWER measurement.

It is recommended for user to provide calibration:
- For self-made cables or matching devices;
- Annually for "POWER" input.

To approximate 121.5 MHz and 406 MHz amplitude detector nonlinearity, the next equation used in BT-611M:

Power =A*X² +B*X + C, where X is ADC data. Special program calculates A, B, C factors by comparing the readings of reference power meter and internal ADC counts at 8 power points. It is recommended to use the beacon as source power, with possibilities output power adjusted over the range 0.2W … 8W for 406 MHz and 5 mW …130 mW for 121.5 MHz transmitters. For 121.5 MHz channel power calibration standard signal generator may be used.

The next power points recommended for calibration "POWER" input (approximate):

406 MHz transmitter (W):

0.2, 0.3, 0.5, 1.2, 2, 3.5, 5, 8

For 121.5 MHz transmitter (mW):

4, 6, 10, 15, 25, 50, 80, 130.

To provide reference power value, the spectrum analyzer (SA) may be used (e.g. HP8593e). It is need to connect auxiliary attenuator at SA input, to prevent failure because of high power level. Reference power level applied to the cable under calibration should be calculated taking into account cable and attenuator losses.

Calibration block diagram shown in the Figure 17.

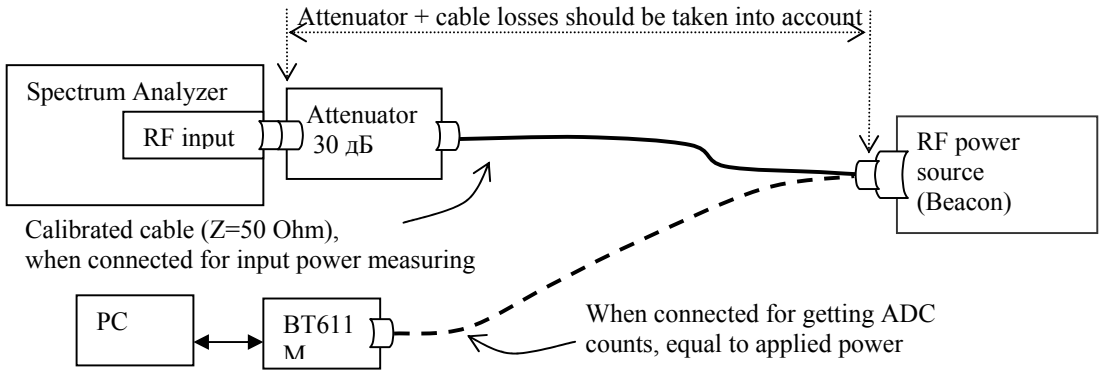

Figure 18 – connections diagram for power calibration

For 406 MHz power calibration set the analyzer to video triggered zero span mode with sweep duration of 500 ms. To avoid modulation influence (if present) to the envelop, IF bandwidth of 100 kHz may be selected. Power readings recommended to be taken at 150 ms marker position. For 121.5 MHz signal manual synchronization may be more convenient.

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To provide BT-611M equivalent ADC counts it is need to choose *Channel 406(121) file #* as ADC in the "SETTINGS" window. The ADC counts may be read at any appropriate window after running measurements. Note that 121 ADC data must be divided by 10. It is recommended to calculate and use mean value for 3…5 measurements.

During calibration, the cable in use consequently connected to the attenuator or BT-611M for every power point.

It is recommended to count the power point as maximum if ADC reading exceeds 210.

After all data from 8 power points (406 or 121) will be collected they should be filled up to appropriate table (Figure 19) at the CALIBRATE window. After file number **calibr *** must be S/N beacon tester in next form (U10027), for example. Then it is need to click **calculate** soft key, select file number you want to appoint at **File window** and click **save** soft key**.** User may prepare eight files for different cable length and test site conditions (including tests with measuring antenna).

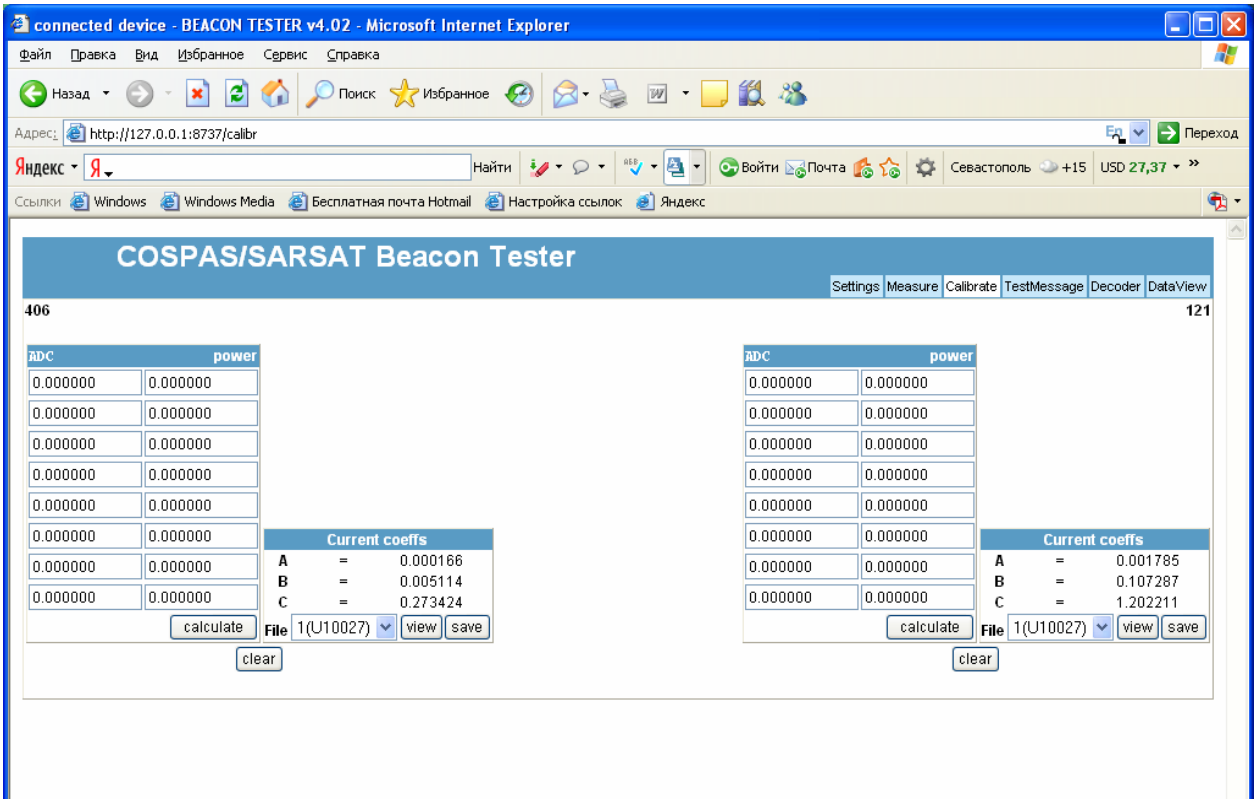

Figure 19 The table for A, B, C factors calculation

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9 Annual Verification

The annual verification includes power calibration described above and reference oscillator frequency correction. Because of high stability reference oscillator used, it is recommended first to test frequency accuracy. For that connect reference frequency source adjusted to 5±5 dBm at 406025000 Hz to ANTENNA input and start measurement. Check measured frequency value at 406 Phase modulation window. Correction is needless in the case measured accuracy found within ±10 Hz.

Otherwise for frequency correction:

- turn the unit upside-down an open the bottom cover to see RF PCB (use Figure 20 for reference);
- Adjust power level of reference signal source to 5±5 dBm at 406025000 Hz,
- Warm up about 1 hour the unit and reference frequency source.
- Connect reference signal source to ANTENNA input and start measuring;
- By observing frequency readings at **406 Phase modulation** window, adjust the trimmer (see Figure 20) to get frequency value as close as possible to the reference one. The tolerance should not exceed ±10 Hz.
- Screw the bottom cover back.

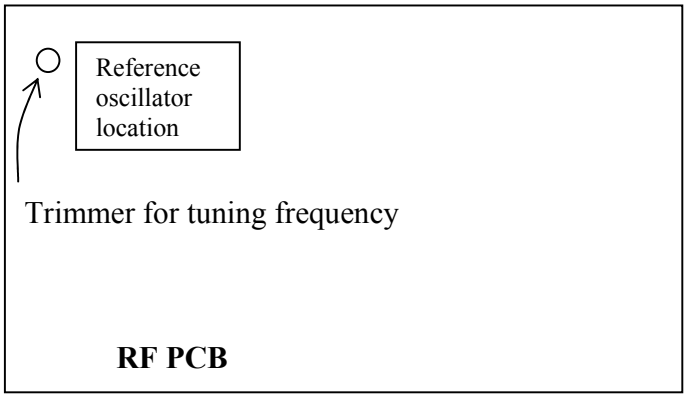

Figure 20 – location of trimmer potentiometer

10 Fault removal.

Manufacturer only shall provide any repairing and adjusting procedures.

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11 General information

11.1 COSPAS-SARSAT beacon tester BT-611M

Serial № ……..

The BT-611M is designed for high accuracy and resolution measurements of signal parameters of 406 MHz Emergency beacons to check its compliance with COSPAS-SARSAT requirements.

Country of origin: **UKRAINE**

11.2 Component Parts

Part name	Quantity
1. BT-611M measuring unit	1
2. Antenna, consisting of:	
- Antenna rod	1
- The trivet with cable	1
- Supporting legs	3
- Strip	3
3. RF calibrated cable	1
4. USB cable A/B	1
5. Three prong AC power cord	1
6. User Manual (this document)	1

11. 3 BT-611M serial № …….. confirms with technical documentation and approved as ready to use

Tested and approved by…… /……./
(Signature)

Warranty

- manufacturer guaranties proper operation of the devise provided it was kept, mounted, and maintained according to the requirements stated in the User Manual
- storage warranty period is 2 years sins the day of shipment
- operation warranty period is 1 year since the day of putting into operation, but within storage period.

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Annex 1
The results of testing simulated signals

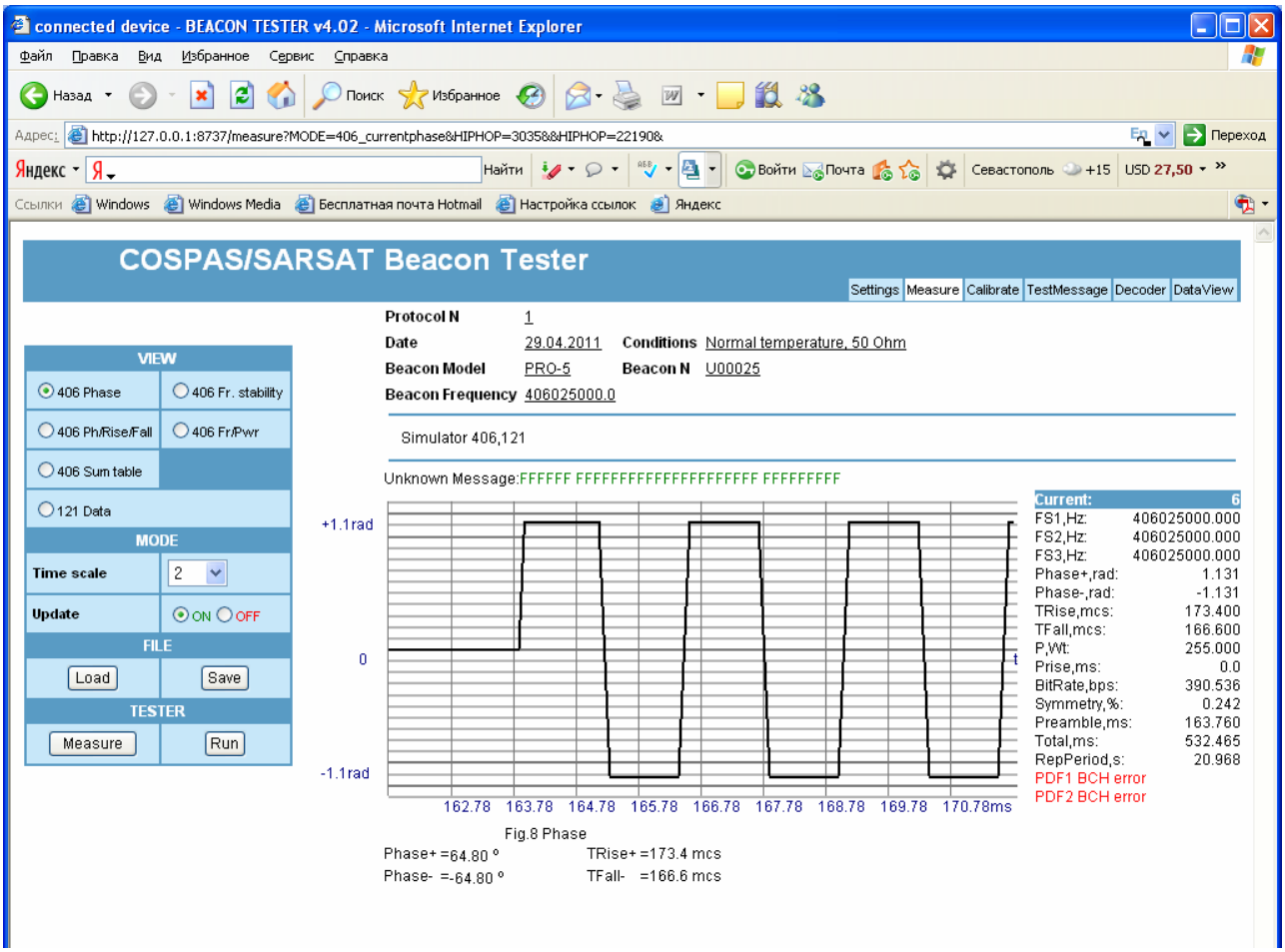

Figure A.1 – Instantaneous phase and other parameters of 406 MHz simulated beacon signal, scale 2

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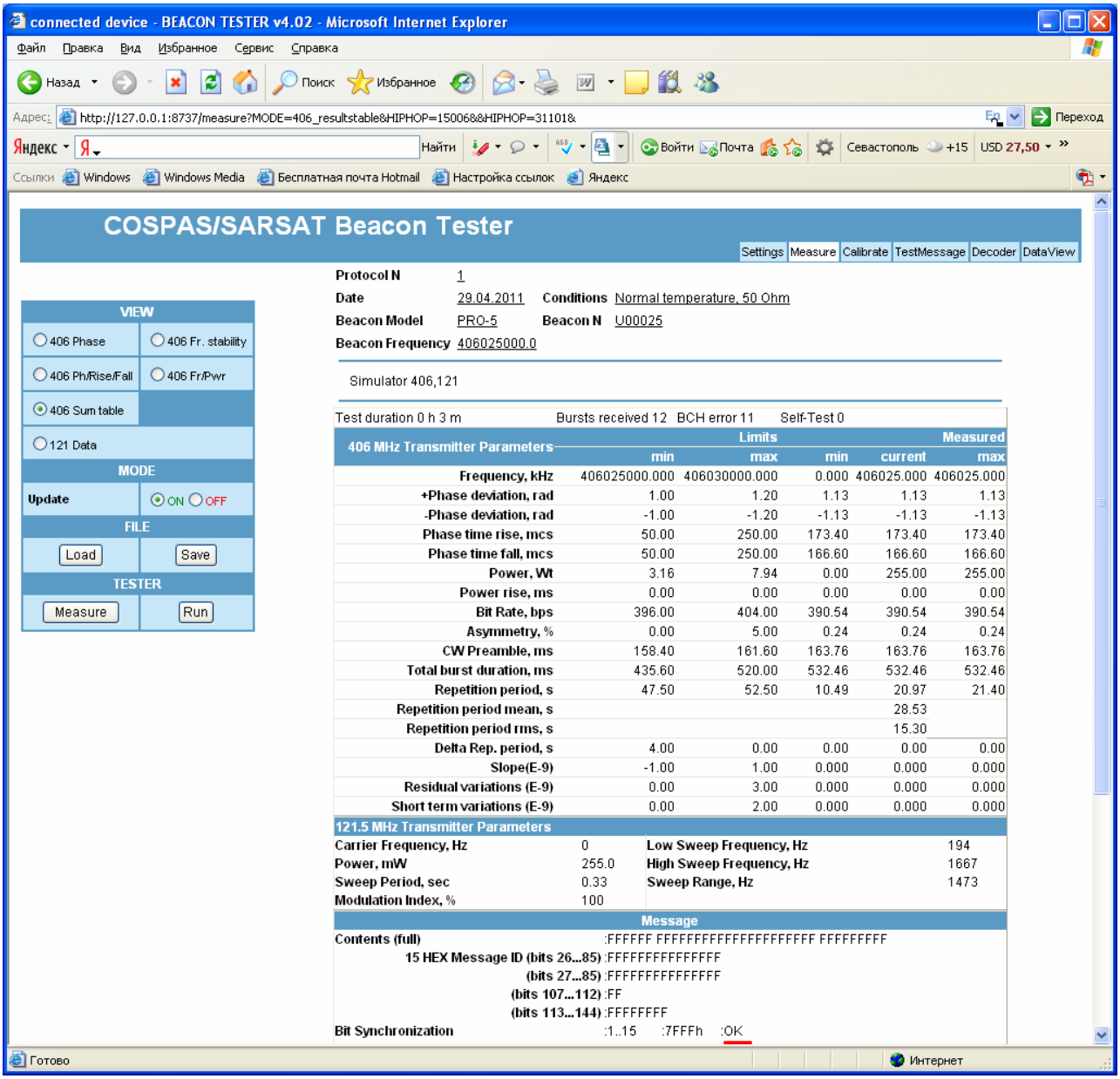
connected device - BEACON TESTER v4.02 - Microsoft Internet Explorer
COSPAS/SARSAT Beacon Tester
Settings Measure Calibrate TestMessage Decoder DataView
VIEW
406 Phase
406 Fr. stability
406 Ph/Rise/Fall
406 Fr/Pwr
406 Sum table
121 Data
MODE
Update
ON OFF
FILE
Load
Save
TESTER
Measure
Run
Protocol N 1
Date 29.04.2011 Conditions Normal temperature, 50 Ohm
Beacon Model PRO-5 Beacon N U00025
Beacon Frequency 406025000.0
Simulator 406,121
Test duration 0 h 3 m Bursts received 12 BCH error 11 Self-Test 0
406 MHz Transmitter Parameters
Limits
Measured
min max min current max
Frequency, kHz 406025000.000 406030000.000 0.000 406025.000 406025.000
+Phase deviation, rad 1.00 1.20 1.13 1.13 1.13
-Phase deviation, rad -1.00 -1.20 -1.13 -1.13 -1.13
Phase time rise, mcs 50.00 250.00 173.40 173.40 173.40
Phase time fall, mcs 50.00 250.00 166.60 166.60 166.60
Power, Wt 3.16 7.94 0.00 255.00 255.00
Power rise, ms 0.00 0.00 0.00 0.00 0.00
Bit Rate, bps 396.00 404.00 390.54 390.54 390.54
Asymmetry, % 0.00 5.00 0.24 0.24 0.24
CW Preamble, ms 158.40 161.60 163.76 163.76 163.76
Total burst duration, ms 435.60 520.00 532.46 532.46 532.46
Repetition period, s 47.50 52.50 10.49 20.97 21.40
Repetition period mean, s 28.53
Repetition period rms, s 15.30
Delta Rep. period, s 4.00 0.00 0.00 0.00 0.00
Slope(E-9) -1.00 1.00 0.000 0.000 0.000
Residual variations (E-9) 0.00 3.00 0.000 0.000 0.000
Short term variations (E-9) 0.00 2.00 0.000 0.000 0.000
121.5 MHz Transmitter Parameters
Carrier Frequency, Hz 0
Power, mW 255.0
Sweep Period, sec 0.33
Modulation Index, % 100
Low Sweep Frequency, Hz 194
High Sweep Frequency, Hz 1667
Sweep Range, Hz 1473
Message
Contents (full) :FFFFFF FFFFFFFFFFFFFFFFFFFF FFFFFFFF
15 HEX Message ID (bits 26...85) :FFFFFFFFFFFFFF
(bits 27...85) :FFFFFFFFFFFFFF
(bits 107...112) :FF
(bits 113...144) :FFFFFFFF
Bit Synchronization :1..15 :7FFFh :OK
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Figure A.2a – Summary table for 406/121.5 MHz simulated beacon signal parameters

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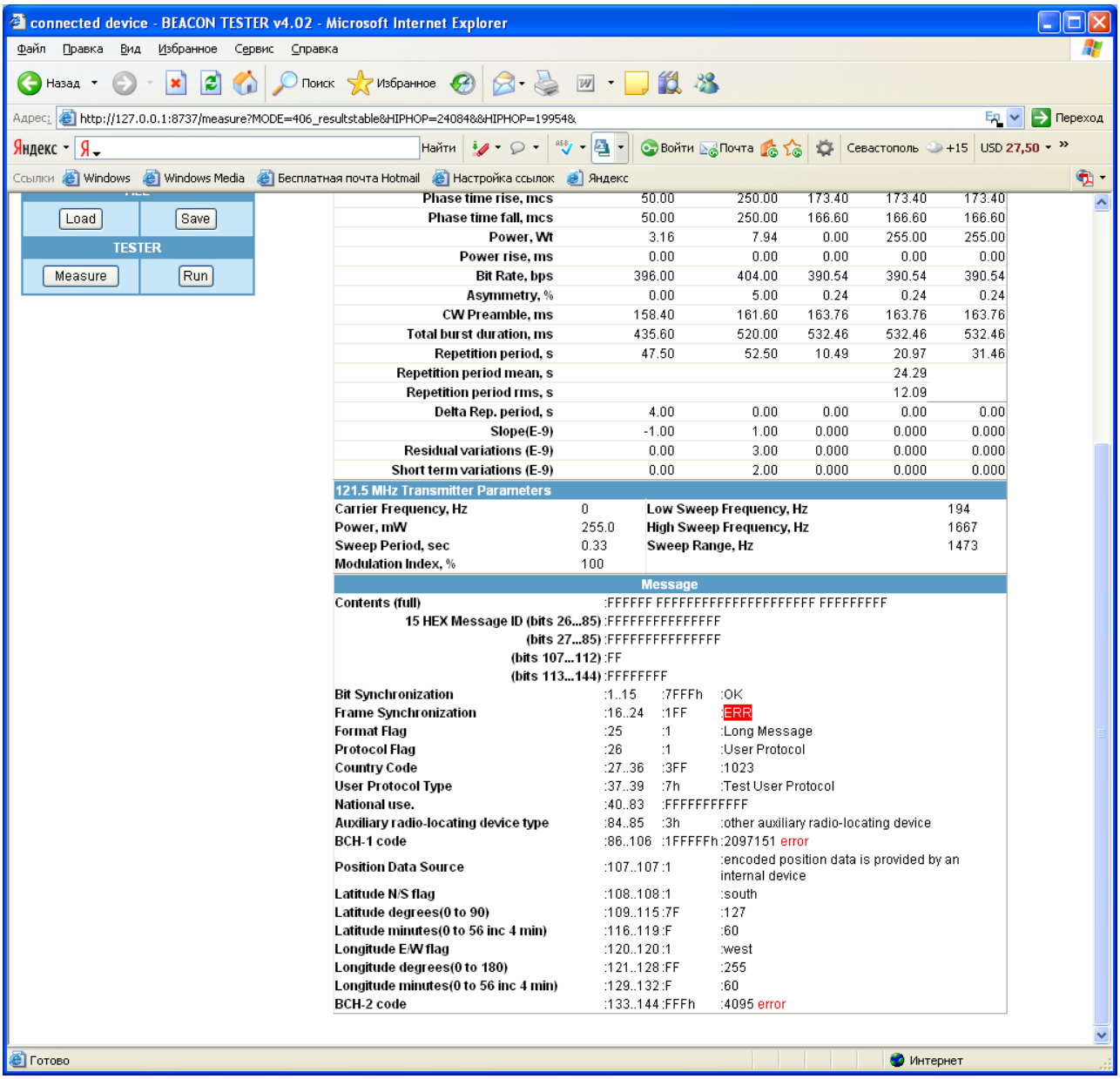

Phase time rise, mcs	50.00	250.00	173.40	173.40	173.40
Phase time fall, mcs	50.00	250.00	166.60	166.60	166.60
Power, Wt	3.16	7.94	0.00	255.00	255.00
Power rise, ms	0.00	0.00	0.00	0.00	0.00
Bit Rate, bps	396.00	404.00	390.54	390.54	390.54
Asymmetry, %	0.00	5.00	0.24	0.24	0.24
CW Preamble, ms	158.40	161.60	163.76	163.76	163.76
Total burst duration, ms	435.60	520.00	532.46	532.46	532.46
Repetition period, s	47.50	52.50	10.49	20.97	31.46
Repetition period mean, s				24.29	
Repetition period rms, s				12.09	
Delta Rep. period, s	4.00	0.00	0.00	0.00	0.00
Slope(E-9)	-1.00	1.00	0.000	0.000	0.000
Residual variations (E-9)	0.00	3.00	0.000	0.000	0.000
Short term variations (E-9)	0.00	2.00	0.000	0.000	0.000

121.5 MHz Transmitter Parameters			
Carrier Frequency, Hz	0	Low Sweep Frequency, Hz	194
Power, mW	255.0	High Sweep Frequency, Hz	1667
Sweep Period, sec	0.33	Sweep Range, Hz	1473
Modulation Index, %	100		

Message			
Contents (full)	:FFFFFF FFFFFFFFFFFFFFFFFFFF FFFFFFFF		
15 HEX Message ID (bits 26...85)	:FFFFFFFFFFFFFF		
(bits 27...85)	:FFFFFFFFFFFFFF		
(bits 107...112)	:FF		
(bits 113...144)	:FFFFFFFF		
Bit Synchronization	:1..15	:7FFFh	:OK
Frame Synchronization	:16..24	:1FF	:ERR
Format Flag	:25	:1	:Long Message
Protocol Flag	:26	:1	:User Protocol
Country Code	:27..36	:3FF	:1023
User Protocol Type	:37..39	:7h	:Test User Protocol
National use.	:40..83	:FFFFFFFFFF	
Auxiliary radio-locating device type	:84..85	:3h	:other auxiliary radio-locating device
BCH-1 code	:86..106	:1FFFFFh	:2097151 error
Position Data Source	:107..107	:1	:encoded position data is provided by an internal device
Latitude N/S flag	:108..108	:1	:south
Latitude degrees(0 to 90)	:109..115	:7F	:127
Latitude minutes(0 to 56 inc 4 min)	:116..119	:F	:60
Longitude E/W flag	:120..120	:1	:west
Longitude degrees(0 to 180)	:121..128	:FF	:255
Longitude minutes(0 to 56 inc 4 min)	:129..132	:F	:60
BCH-2 code	:133..144	:FFFh	:4095 error

Figure A.2b – Summary table for 406/121.5 MHz simulated beacon signal parameters

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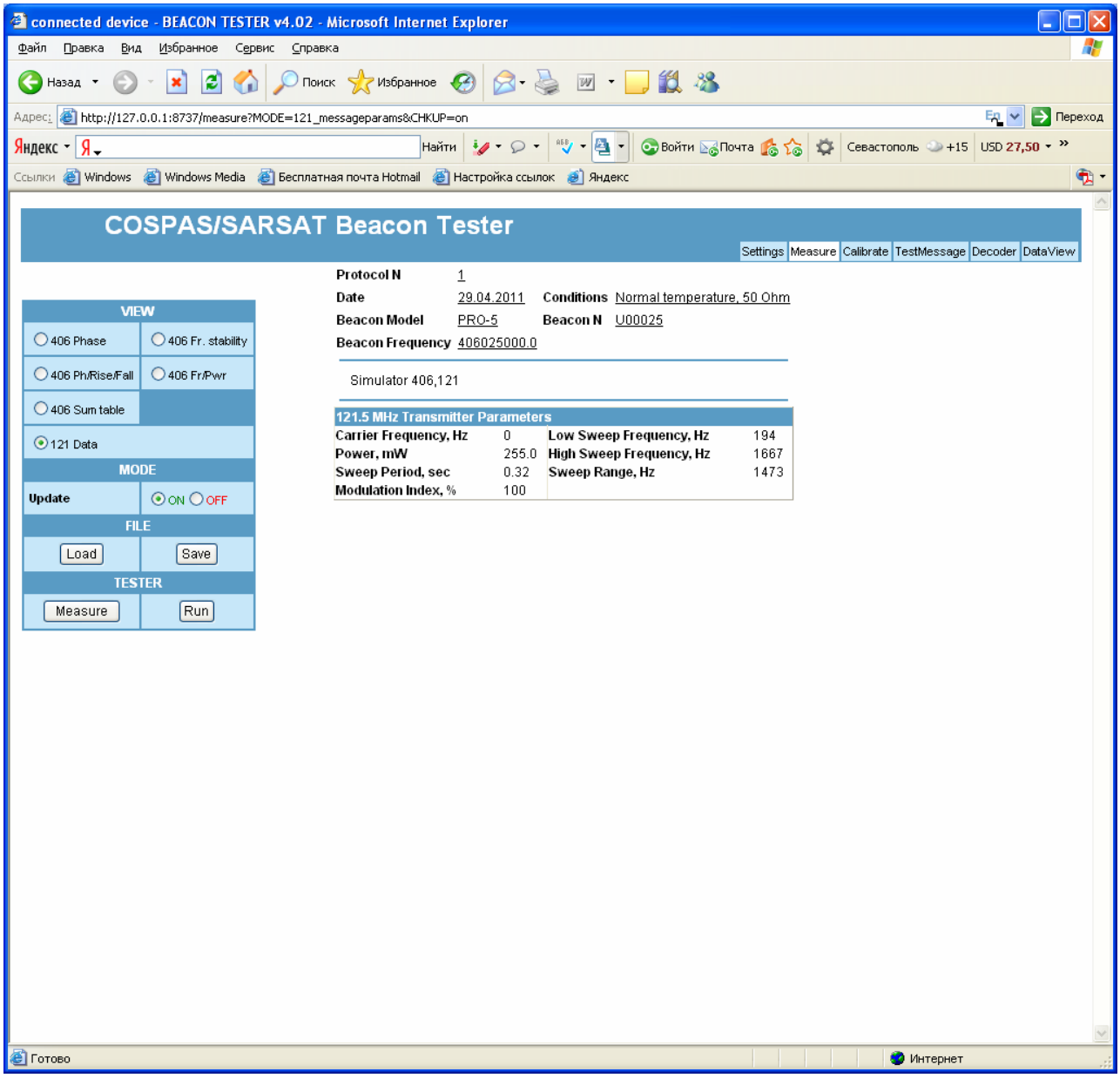

Figure A.2c – Summary table for 406/121.5 MHz simulated beacon signal parameters

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